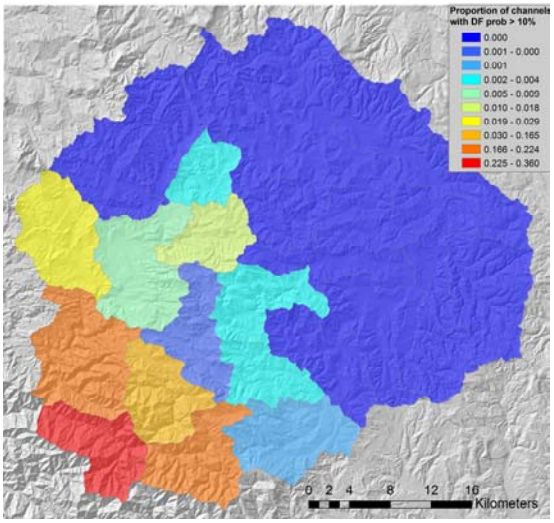
Upper Nehalem Watershed Analysis
Part II - Analysis



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Part II – WATERSHED ANALYSIS

The Analysis portion of the document addressed habitat conditions described in the assessment phase (Part I) as they relate to the utility and quality of aquatic and riparian habitat and it subsequently addressed forest management considerations to facilitate attaining desired future habitat conditions in a timely fashion. The Analysis Section is organized: (1) to identify areas where resource conditions are consistent with the range of variation typically found under natural disturbance regimes for the watershed (defined in the Northwest Oregon Forest Management Plan [NW FMP; ODF 2001] as properly functioning habitat conditions (PFC); (2) to anticipate where conditions in the basin are on a likely trajectory to achieve PFC in a timely fashion under future FMP or SAH management scenarios; and (3) to assess what factors or physical processes in the basin may be limiting the ability to readily achieve PFC.

Four primary topics including: limiting factors, alternative vegetative management, slope stability and road management, were assessed to determine if aquatic and riparian resources were functioning properly. A set of Key Questions are specifically addressed and a report chapter is dedicated to each topic as follows.

Chapter 11 – Limiting Factors evaluates in-channel habitat values for large wood, sediment accumulations and surface water temperatures as they relate to the range of natural variation found in monitoring data from unmanaged reference sites along the Oregon North Coast Range. Areas where functions were impaired or limited represent potential management opportunities to enhance and promote PFC in the long-term.

Chapter 12 – Alternative Vegetation Management considers areas in the basin where riparian zones are consistent with or on a trajectory to achieve PFC for riparian functions of wood recruitment and shade under current management programs. Alternative management measures for specific areas in the watershed not on a timely PFC-trajectory are discussed to facilitate achieving desired conditions more quickly than under either the NW FMP or SAH measures.

Chapter 13 – Slope Stability addresses the potential for hillslope failures to pose a high risk to either downstream sediment accumulations or channel scour and the potential for management activities to influence slope failure rates. Both sediment and large wood sources were evaluated and ranked in accordance to their delivery potential to the channel network and fish-bearing waters.

Chapter 14 – Road Management assesses road conditions in the transportation network in relation to which ones need repair, vacation, relocation and which stream crossings should be considered for replacement. Recommended specific locations in the road network are prioritized for management actions.

Finally, the Analysis Section includes Chapter 15 – Summary that provides a synthesis of individual scientific disciplines and watershed processes used to help rate recommended management considerations in accordance with prospective habitat benefits. A prioritized list of potential sites for management activities on ODF lands in the upper Nehalem Watershed is included. A review of the critical question responses and a list of data gaps are also included in the summary.

11. LIMITING FACTORS

Identification of habitat factors limiting fish populations can not be determined without documenting a change in a factor and a subsequent increase in population size. Given the complexity of natural systems and the anadromous life history of many salmonid populations, the ecological concepts of limiting factors and population release are rarely empirically demonstrated. As a surrogate method, fish scientists often measure physical habitat characteristics in a target system and compare these measurements to values deemed suitable for fish. Caution must be exercised with this surrogate approach since there is no single value that can accurately characterize "healthy" fish habitat. Fish populations have adapted to a range of habitat conditions that occur naturally, including conditions under natural disturbance regimes.

For the purposes of this analysis, properly functioning aquatic habitat conditions (PFCs) for ODF lands in the upper Nehalem watershed were determined by comparing critical habitat attributes in surveyed stream reaches with reference values. Reference values were derived from available data collected on unmanaged lands in the region and accepted standards established for salmonid fishes in Pacific Northwest rivers. The following sources were used in generating reference conditions: Oregon Department of Fish and Wildlife's Aquatic Inventory Project (ODFW AIP) data; US Forest Service natural range of variation data from Sandy River OR (USFS 1996); Fox (2001) data from unmanaged streams in SW Washington; FWS/NOAA Fisheries Table of Population Indicators for Use in the Northwest Forest Plan Area (USFWS 1998; NMFS 1999).

Two comparisons were made for the analysis of limiting factors. The first was a watershed-to-watershed comparison of wood and substrate habitat indicators. For this comparison the

statistical distributions of the upper Nehalem River data, the Oregon AIP reference data sets and other reference values were evaluated where applicable. The second comparison was a performed on a reach-specific basis.

The reference values used in the watershed-to-watershed comparison are summarized in Table 11-2. Data are presented with descriptive statistics to help quantify the variation inherent in habitat data. A habitat attribute from the Nehalem habitat assessment was determined to be a potential limiting factor if it fell outside the range of reference values. In this analysis, we assume fish in the Nehalem River have adapted to a range of natural conditions represented by the referenced values and that fish productivity would improve the closer Nehalem habitat conditions emulate channel data from unmanaged streams. Based on our professional opinion, we assume forestry management actions that move limiting habitat attributes closer to, and ultimately within, the range of variation identified for reference conditions will support aquatic habitat PFCs in the upper Nehalem River. Comparisons of upper Nehalem River wood and substrate indicators from various reaches in the watershed with regional reference values can be found in Tables 11-2 and 11-3. Table 11-2 summaries the distribution of the data for the entire watershed while Table 11-3 show the distribution of the data by 5th Field HUC.

The most applicable data for the reach comparison was the ODFW AIP reference stream data set. This data set is composed of 124 surveyed reaches from Oregon Coast Range streams (Table 10-2). It includes a subset of data from 15 surveyed reaches in the North Oregon Coast Ecoregion and 2 surveyed reaches in the Nehalem River basin. The Oregon Coast data set was the largest and most complete data set available for unmanaged forest streams in Oregon and the data was obtained from the closest geographic river systems including many within the same Ecoregion as the Nehalem River. In addition, the reference reaches were morphologically similar to those surveyed for the Nehalem River Assessment (Table 11-1). Thus, we used Oregon Coast reference values for reach comparisons of wood loading in the upper Nehalem. Given the distinct sedimentary geology of the upper Nehalem River basin, we have concluded this system is likely to have higher naturally occurring levels of fine sediments than most nearby North Coast streams. Thus, for reach-specific substrate analysis we used a 30 percent cut off for acceptable levels of fine sediment (<2mm) in riffle gravels. This value approximates the highest substrate level observed in Nehalem River unmanaged stream reaches as well as the volume of fines sufficient to fill the pore spaces of riffle gravels.

Table 11-1. A comparison of morphological characteristics in ODFW AIP reference and assessment reaches (ODFW unpublished data).

Data Set	Number of Reaches	Median Reach Length and Range (km)	Median Active Channel Width and Range (m)	Median Gradient and Range (%)
Oregon Coast Reference Reaches	124	971 174 - 6,776	7.2 1.5 - 31.5	2.3 0.5 – 19.2
North Coast Reference Reaches	15a	702 393 - 2,960	7.5 2.6 – 31.5	1.3 0.6 – 7.4
Nehalem Reference Reaches	2	515 512 - 517	7.1 5.3 - 8.8	3.1 1.8 - 4.4
Nehalem Habitat Assessment	182	1,075 188 – 13,932	6.3 1.8 - 20.8	2.7 0.3 – 27.0

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				FWS/NOAA Fisheries Habitat Indicators	SW Washington Streams (Fox 2001)	Sandy River, OR Natural Range of Variation (USFS 1996)
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
		25th -75th quartiles; median	25th -75th quartiles; median	25th -75th quartiles; median	Range		25th -75th quartiles; median	Range (mean ± 1 St. Dev.; median)
Pieces large wood	Number of wood pieces (>5cm diameter x 3 m) length per 100m stream	**16.9-31, 22.7**	8.2-22.6, 14.0	2.6-16.9, 14.5	29.9-35	NA	7.9-19.2, 20.2* *>10 cm diameter and 2 m length	NA
Volume large wood	m^3 of wood (>15 cm diameter x 3m length / 100 m stream	**20.7-52.4, 32.7**	17.1–57.7 31.3	12.4-44.7, 28.4	21.2-46.2	NA	NA	NA

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				FWS/NOAA Fisheries Habitat Indicators	SW Washington Streams (Fox 2001)	Sandy River, OR Natural Range of Variation (USFS 1996)
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
Key pieces of wood	Number of wood pieces > 60 cm diameter and > 12 m long/100 m stream	**0.5-1.8, 0.8**	0.5- 2.8, 1.4	0.1-1.4, 0.9	0.0-1.4	>5.0 key pieces per 100m (>61cm diameter and > 15 m length)	0.3 – 2.6, 0.7* (*>61cm diameter and 15 m length per 100 m	0.0-4.0; 0.6 (* >91 cm diameter and 15 m length per 100 m
Percent fines in riffles	Visual estimate (%) of substrate of particles less than 2 mm diameter	**11-36, 22**	8-22,13	13-23, 20	13-29	If fines are dominant, substrate is not properly functioning condition	NA	NA
Percent gravel in riffles	Visual estimate (%) of substrate of particles between 2 and 64 mm diameter	**31-51, 39**	27 – 53, 38	27 – 33, 29	53-66	Gravel or cobble substrate with clear interstitial spaces is properly functioning condition	NA	NA

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				FWS/NOAA Fisheries Habitat Indicators	SW Washington Streams (Fox 2001)	Sandy River, OR Natural Range of Variation (USFS 1996)
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
Percent bedrock in stream	Visual estimate (%) of substrate composed of solid bedrock	**1-9, 5**	1-13, 5	0-11, 5	0-6	If bedrock is dominant, substrate is not properly functioning condition	NA	NA

Table 11-3. Distribution of data for critical substrate and wood habitat indicators by 5th Field HUC

5th Field HUC	Habitat Indicator	Total Range	Interquartile Range (25th-75th)	Median
1710020201	Percent fines in riffles	0-67	5-40	24
	Percent gravel in riffles	20-67	32-48	38
	Pieces large wood/100m stream	56-54	20-32	23
	Volume large wood (m^3/ 100 m)	7-155	21-54	29
	Key pieces large wood/100 m	0-4.3	0.4-31.2	0.6
1710020202	Percent fines in riffles	0-97	21-42	29
	Percent gravel in riffles	0-67	32-36	36
	Pieces large wood/100m stream	5-77	18-33	24
	Volume large wood (m^3/100 m)	7-192	22-56	35
	Key pieces large wood/100 m	0.1-9.9	0.7-3.0	1
1710020203	Percent fines in riffles	0-95	10-30	19
	Percent gravel in riffles	0-92	30-46	40
	Pieces large wood/100m stream	2-56	17-30	22
	Volume large wood (m3/100 m)	2.1-259.2	19.95-49.7	32.4
	Key pieces large wood/100 m	0-4.8	0.3-1.6	0.9

The following questions were addressed to help identify habitat factors that may limit achievement of (PFC).

1. Are *there sub-watersheds where the current level of in-stream wood is a limiting factor for achieving properly functioning aquatic systems?*
2. *Are there sub-watersheds were stream sediment deposition (associated with hillslopes and/or erosion) is a limiting factor for achieving properly function aquatic systems?*
3. *Given the stream temperatures that are reasonably achievable, what is the likelihood (rate as high, moderate, low, or unknown) that stream temperatures and/or shade conditions are a limiting factor for achieving properly functioning aquatic systems?*
4. *Are there any other conditions limiting the achievement of PFCs?*

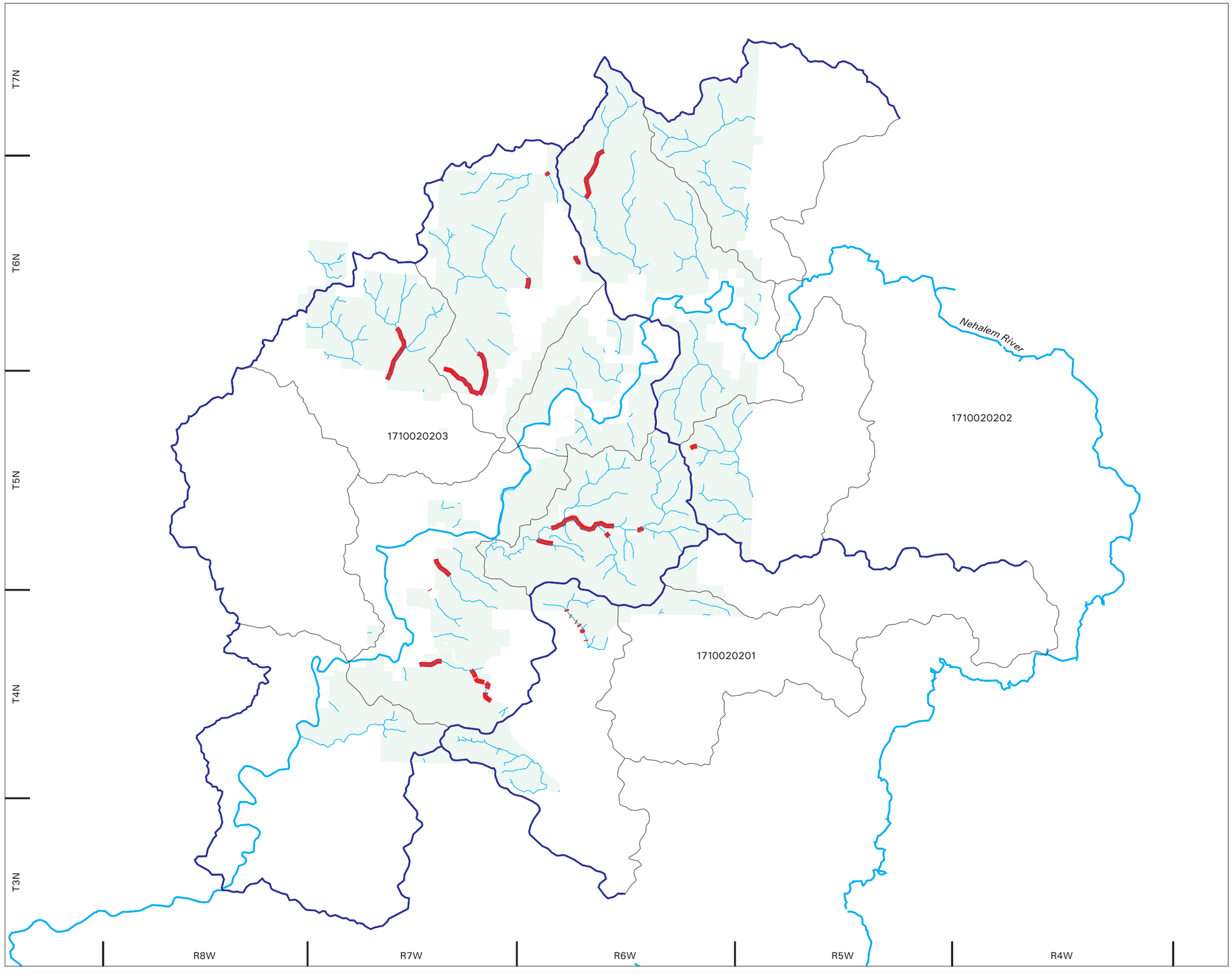
11.1 INSTREAM WOOD LOADING OF LARGE WOOD

In-stream wood is a critical habitat component for freshwater fishes and freshwater life stages of anadromous fishes as it contribute to habitat complexity. Wood also provides cover and nutrients and interacts with river flow to trap sediment or create new habitat types such as pools, off-channel habitat, and undercut banks. Coho salmon juveniles will use slower water habitats with complex structure as a refuge from high winter flows (Nickelson et al. 1992) as well as during the summer low-flow period (Grette and Salo 1986). Adult steelhead require holding and resting sites during their upstream migration (Spence et al. 1996). Large in-stream wood, boulders, and other structures create the necessary slow water and pool habitat needed for resting and cover for adult steelhead during their upstream migration as well as for juveniles rearing in freshwater (Spence et al. 1996). Similar associations with in-stream structure have been documented for other species of fish including cutthroat trout and Chinook salmon.

A comparison of the statistical distributions of the ODFW AIP reach data (Tables 11-2, 11-3) indicated that the upper Nehalem River Project Area streams were similar in character to unmanaged references streams and conditions with respect to in-stream wood levels. The interquartile range and median values for pieces, key pieces and volume of large wood in the upper Nehalem assessment reaches were equal to or greater than most reference values. One exception was the median value of key pieces of large wood (0.8 key pieces per 100 m) was slightly more than half of the median value of key pieces for the Oregon Coast reference streams (1.4 kp/100m). From a watershed perspective, the wood levels in the upper Nehalem appeared to be within the natural variation of unmanaged systems, and thus all subwatersheds were classified as functioning within PFC. However, there remains room for improvements to key piece-size large wood levels in specific reaches within the Project Area (Figure 11-1a,b).

Kavanagh et al. (2005) provided reach specific information on levels of wood in Project area streams. There were 11 reaches where the levels of three critical wood indicators fall within the upper quartile range for the Oregon Coast reference streams exceeding 23 pieces, 57.7 m^3, and 2.8 key pieces, per 100 m stream (Table 11-4). A list of 13 reaches where two of three key indicators were similar to Oregon Coast reference values in the upper quartile (75th to 100th percentile) is also included in Table 11-4. These levels of wood are consistently high compared to various reference conditions, and thus, we presume they can be regarded as the most suitable wood habitats in the upper Nehalem watershed.

There were also 41 reaches where key pieces of wood were less than 0.5 pieces per 100m stream (Table 11-5) representing low levels of wood compared to reference values (Figure 11-1a,b).



Legend

- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Key piece wood size is greater than 60cm in diameter and greater than 12m in length.

Map Key

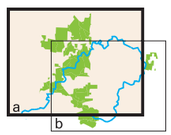


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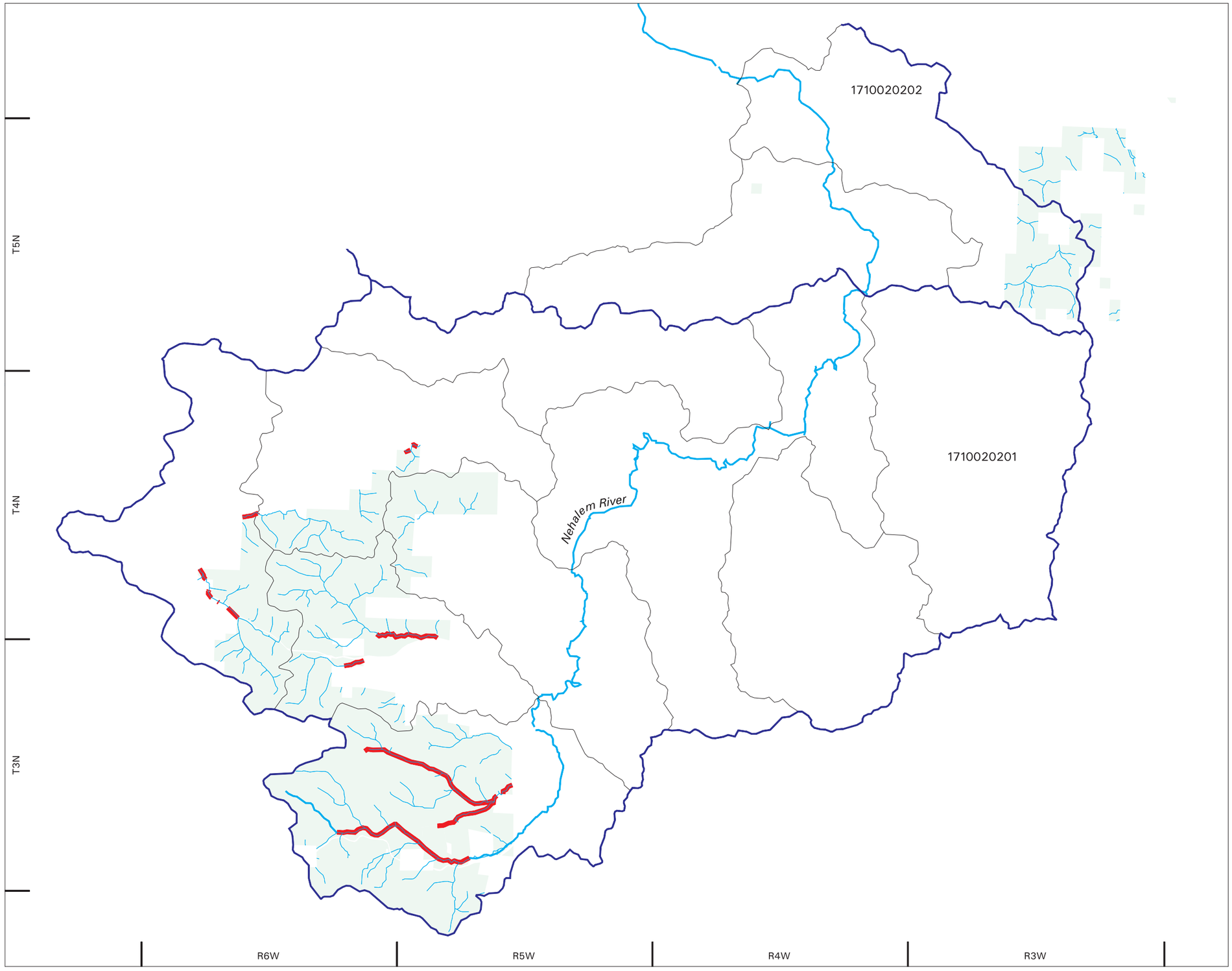
Figure 11-1(a)

Low In-Stream Wood Levels

Astoria District



Legend

- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Key piece wood size is greater than 60cm in diameter and greater than 12m in length.

Map Key

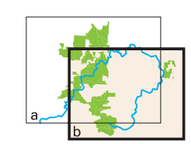


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Figure 11-1(b)

Low In-Stream Wood Levels

Forest Grove District

Included in Table 11-5 and as noted earlier in Section 9.3.4, the following 11 stream reaches were lacking key pieces of large wood: Cow Creek, Gilmore Creek, Nettle Creek (2 reaches), Osweg Creek, Quartz Creek, South Fork Quartz Creek, Walker Creek (3 reaches), and Dell Creek (Kavanagh et al. 2005). It is our professional opinion these reaches would benefit from management actions that improve instream levels of wood loading.

Table 11-4. Stream reaches with the highest levels of wood loading by 5th field HUC. (At least two of three indicator wood levels exceed the Oregon Coast reference upper quartile values of 22.6 pieces, 57.7 m^3, and 2.8 key pieces, per 100 m stream).

5th Field HUC	Stream	Pieces large wood	Volume large wood	Key pieces large wood
1710020201	Lousignont Creek	39.1	81.5	4.3
	North Fork Rock Creek	51.4	90.6	ND
	South Fork Rock Creek	53.6	86.0	ND
	North Fork Wolf Creek	31.0	54.4	3.9
	Lousignont Creek	40.7	58.5	1.5
1710020202	Fishhawk Creek	31.2	56.3	3.4
	Fishhawk Creek	33.2	105.9	5.7
	Trestle Creek	32.1	79.7	3.0
	Warner Creek Tributary C	64.2	103.4	6.6
	Deep Creek	52.6	115.4	7.4
	Deep Creek	77.4	192.1	9.5
	Deep Creek	28.2	55.9	3.7
	Deep Creek Tributary	61.9	116.3	5.2
	Deep Creek Tributary	65.3	155.4	9.9
	Cow Creek	38.4	64.5	2.6
1710020203	Gilmore Creek	30.3	76.1	3.6
	Walker Creek	45.3	92.4	2.1
	South Fork Walker Creek	56.1	112.0	4.2
	North Fork Walker Creek	35.3	81.9	1.3
	Slaughters Creek	22.0	66.0	
	Beneke Creek	29.9	79.2	3.8
	Hamilton Creek Tributary A	27.4	68.5	2.4
	Hamilton Creek Tributary B	34.8	63.0	2.3
	Buster Creek Tributary A	45.4	259.2	4.8
	Stanley Creek	40.4	67.3	1.2
	Kline's Creek	36.3	67.2	2.6
	Quartz Creek	50.5	59.8	0.7

Table 11-5. Stream reaches with low levels of key pieces of large wood (<0.5 pieces/ 100m).

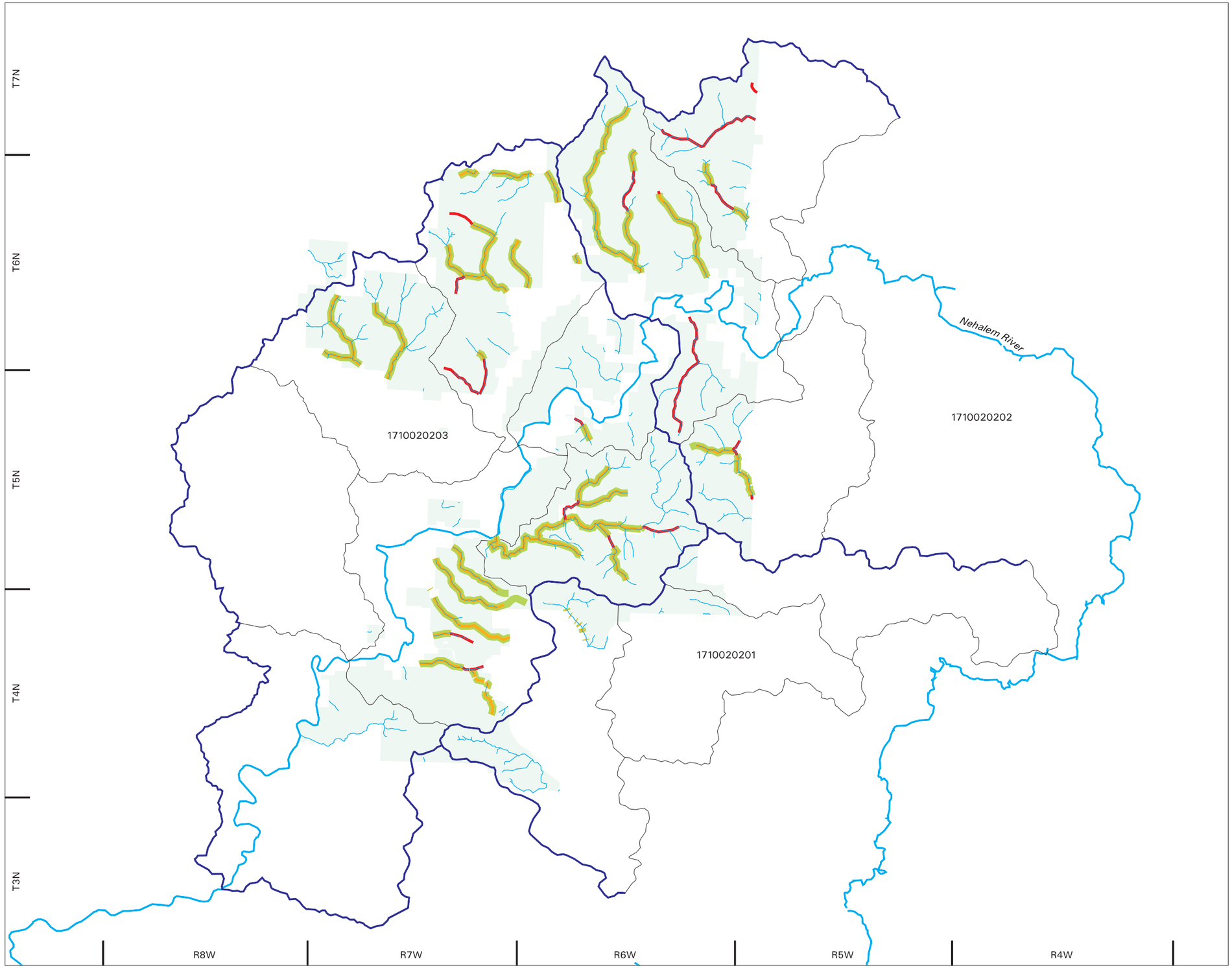
1710020101		1710020102		1710020103	
Stream	**Key Pieces Large Wood**	**Stream**	**Key Pieces Large Wood**	**Stream**	**Key Pieces Large Wood**
Derby Creek	0.02	Northrup Creek	0.1	Hamilton Creek	0.3
Dell Creek	0.0	Northrup Creek Tributary A	0.2	Hamilton Creek	0.3
North Fork Wolf Creek	0.2	Northrup Creek	0.4		
North Fork Wolf Creek	0.3	Deep Creek	0.3	Hamilton Creek Tributary A	0.1
Rock Creek	0.4			Buster Creek	0.4
Rock Creek	0.4			Buster Creek	0.4
Wolf Creek	0.1			Buster Creek	0.2
Upper Nehalem River	0.4			Nettle Creek	0.0
Lousignont Creek	0.2			Nettle Creek	0.0
				Stanley Creek	0.4
				Cow Creek	0.1
				Cow Creek	0.0
				Kline's Creek	0.2
				Quartz Creek	0.0
				South Fork Quartz Creek	0.3
				South Fork Quartz Creek	0.0
				Gilmore Creek	0.0
				Gilmore Creek	0.3
				Gilmore Creek	0.2
				Gilmore Creek	0.1
				Gilmore Creek Tributary A	0.2
				Gilmore Creek Tributary A	0.2
				Beneke Creek	0.3
				Trailover Creek	0.1
				Walker Creek	0.0

11.2 SEDIMENT DEPOSITION

Sediment composition is also a critical habitat variable for properly functioning aquatic systems. High amounts of gravels and cobbles typically are considered healthy since they provide substrates for incubation of fish embryos, and support diverse macroinvertebrate communities. High levels of bedrock throughout a stream can indicate a deficiency in coarse sediment input, or scouring of the stream bed and downstream movement of sediment. When levels of fine sediments in the substrate are high, intergravel spaces and flow of water and oxygen to incubating eggs can be reduced. Over time, fines can build up cementing gravels into the streambed and reducing their utility for invertebrate habitat and fish spawning habitat. Thus, stream gravels need to be relatively free of fine sediments for proper function.

A comparison of the statistical distributions of the reach data (Table 11.2) indicated that the ODF streams in the upper Nehalem River Project Area were similar to unmanaged references streams and conditions with respect to substrate composition. The interquartile range and median values for percent fines, gravels, and riffles in the upper Nehalem assessment reaches were similar to reference conditions. One exception was the range and median value of percent fines (<2mm) in the upper Nehalem (11-36, 22%) was greater than the range and median for the Oregon Coast reference streams (8-22, 13%), and the range was more extensive than the range for fines in North Oregon Coast Reference Streams (13-23%). However, when considering the fines levels in the unmanaged upper Nehalem reaches (13–29%), it appeared that the underlying geology naturally supports higher amounts of fines than other Oregon coast streams. From a watershed perspective, the substrate composition in the upper Nehalem appeared to be within the natural variation of unmanaged streams, given the geology of the watershed. Thus, it is our opinion, all of the 5th field subwatersheds remain within PFC. Similar to wood loading, there were specific stream reaches with large variations of substrate composition including reaches with high quality substrates and reaches that could benefit from substrate improvements (Figure 11-2a,b).

Kavanagh et al. (2005) provided reach specific information on substrate composition in riffle habitats within Project area streams. Riffle reaches with an approximate 5 percent gradient, relatively low levels of fines and high levels of gravels are listed in Table 11-6. These reaches represent potentially suitable habitat for spawning salmonid fishes, given the high quality of substrate observed. Additional field verification would be needed to verify low levels of embeddedness and or appropriate distributions of gravels to support spawning.

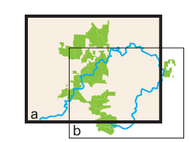


Legend

- Low Fine Sediment Deposition (fines < 30%)
- Potentially Good Spawning Habitat (fines < 30% and gravel > 15%)
- High Fine Sediment Deposition (fines > 30%)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Sediment-size fractions less than 2mm.

Map Key



N

1 Inch = 2.7 Miles

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Miles

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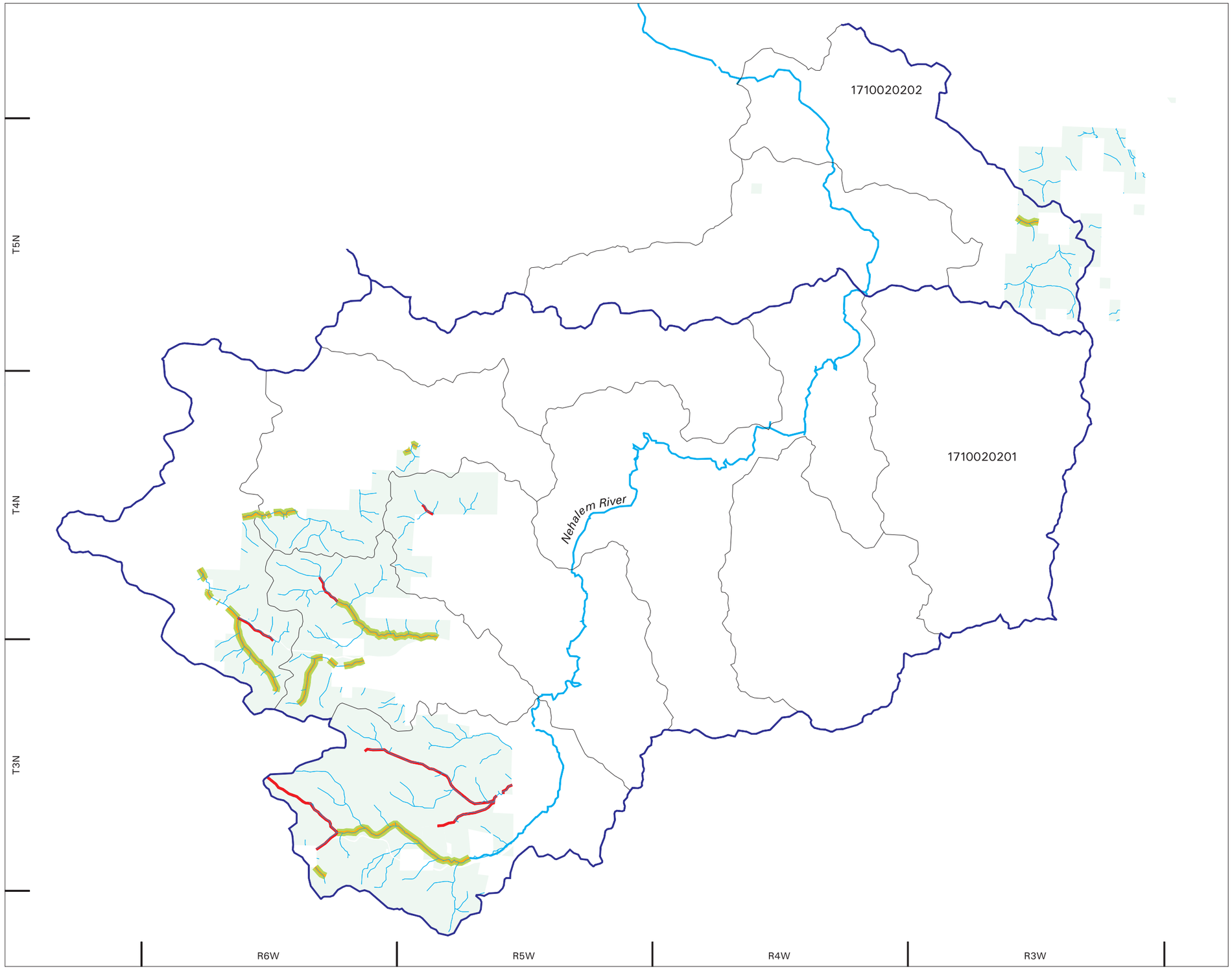
Upper Nehalem Watershed Analysis

Figure 11-2(a)

In-Stream Sediment Deposition in Riffle Habitat

Astoria District

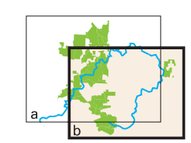


Legend

- Low Fine Sediment Deposition (fines < 30%)
- Potentially Good Spawning Habitat (fines < 30% and gravel > 15%)
- High Fine Sediment Deposition (fines > 30%)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Sediment-size fractions less than 2mm.

Map Key



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1 Inch = 2.3 Miles

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Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-2(b)

In-Stream Sediment Deposition in Riffle Habitat

Forest Grove District

In addition, there are 58 reaches with high levels of fines that could be affecting the habitat value to native fishes. These reaches have more than 30 percent fines in riffles and represent sufficient amounts of fine sediments by volume to fill the pore spaces in riffle gravels and diminish the suitability of these substrates for salmonid fish spawning. Reaches consisting of heavy fine sediment loads within the upper Nehalem are listed in Table 11-7 and shown in Figure 11-2a,b. It is our professional opinion these reaches would benefit from enhancement actions that reduce fine sediment inputs into the stream channels.

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
1710020201	Dell Creek	1	62
	Dell Creek	5	48
	Rock Creek	8	32
	Rock Creek	5	20
	Rock Creek	1	36
	South Fork Rock Creek	3	47
	South Fork Rock Creek	9	50
	South Fork Rock Creek	4	29
	South Fork Rock Creek	2	35
	South Fork Rock Creek	0	67
	North Fork Wolf Creek	24	43
	North Fork Wolf Creek	23	43
	North Fork Wolf Creek	26	65
	North Fork Wolf Creek	26	59
	Wolf Creek	15	34
	Wolf Creek	11	34
	Wolf Creek	15	55
	South Fork Nehalem River	23	28
	Upper Nehalem River	29	36
1710020202	Northrup Creek	10	46
	Northrup Creek	15	39
	Northrup Creek	26	59

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
	Northrup Creek	16	39
	Northrup Creek Tributary A	24	58
	Warner Creek	17	46
	Deep Creek	23	33
	Deep Creek	21	35
	Deep Creek Tributary	23	35
	Deep Creek Tributary	21	35
	Deep Creek Tributary	28	33
	Oak Ranch Creek	16	36
	Cow Creek	16	26
1710020203	Gilmore Creek	15	15
	Walker Creek	17	77
	Cow Creek	13	34
	Slaughters Creek	22	66
	Fishhawk Creek	23	29
	Fishhawk Creek	16	30
	Fishhawk Creek Tributary A	18	31
	Fishhawk Creek Tributary A	21	35
	Beneke Creek	9	39
	Beneke Creek	7	40
	Beneke Creek	10	27
	Beneke Creek	13	41
	Beneke Creek	19	24
	Beneke Creek	8	42
	Beneke Creek	9	55
	Beneke Creek	12	44
	Bull heifer Creek	25	25
	Trailover Creek	22	48
	Walker Creek	9	63
	Walker Creek	11	47

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
	Walker Creek	6	42
	Walker Creek	3	28
	Walker Creek	5	31
	Walker Creek	12	35
	Hamilton Creek	20	30
	Hamilton Creek	20	34
	Hamilton Creek	22	19
	Hamilton Creek Tributary A	17	26
	Hamilton Creek Tributary A	15	32
	Hamilton Creek Tributary A	15	22
	Buster Creek	5	39
	Buster Creek	5	48
	Buster Creek	9	53
	Buster Creek	18	57
	Buster Creek	9	92
	Buster Creek	9	85
	Buster Creek	9	86
	Buster Creek	10	78
	Buster Creek	7	78
	South Fork Walker Creek	9	42
	Stanley Creek	5	58
	Stanley Creek	10	62
	Cow Creek	14	48
	Cow Creek	13	47
	Klines Creek	20	65
	Moores Creek	29	46
	Quartz Creek	21	33
	South Fork Quartz Creek	28	45

Table 11-7. Reaches supporting high sediment loads in the upper Nehalem by 5th field HUC.

1710020101		1710020102		1710020103	
Stream	**Percent Fines**	**Stream**	**Percent Fines**	**Stream**	**Percent Fines**
Derby Creek	33	Lousignont Creek	38	Bull Heifer Creek	32
Lousignont Creek	44	Lousignont Creek	62	Bull Heifer Creek	58
North Fork Lousignont Creek	63	Sager Creek	71	Bull Heifer Creek Tributary A	34
Olson Creek	62	Sager Creek	64	Osweg Creek	86
Clear Creek	55	Sager Creek	86	Buster Creek	37
Bear Creek	31	Fishhawk Creek (above lake)	30	Buster Creek	39
Bear Creek	56	Fishhawk Creek (above lake)	62	Buster Creek Tributary	87
Bear Creek	67	Fishhawk Creek (above lake)	36	Buster Creek Tributary	94
North Fork Wolf Creek	44	Fishhawk Creek (above lake)	33	Buster Creek Tributary	55
South Fork Nehalem River	60	Northrup Creek Tributary A	41	Buster Creek Tributary	64
Upper Nehalem River	61	Trestle Creek	97	Buster Creek Tributary	65
Lousignont Creek	32	Trestle Creek	65	Beneke Creek	40
Lousignont Creek	37	Warner Creek	43	Beneke Creek	40
Lousignont Creek	40	Warner Creek Tributary B	35	Beneke Creek	95
		Warner Creek Tributary C	34	Crawford Creek	68
		Deep Creek	45	Gilmore Creek	53
		Deep Creek	34	Gilmore Creek	48
		Deep Creek	33	Gilmore Creek Tributary A	40
		Deep Creek Tributary	36	Slaughters Creek	40
		Deep Creek Tributary	60	Slaughters Creek	36
		Cow Creek	49	Stanley Creek	37
				Walker Creek	55
				Quartz Creek	38

11.3 SURFACE WATER STREAM TEMPERATURES

Maximum 7-day surface water temperatures under historical reference conditions for the upper Nehalem watershed were modeled based on an assumption of mature forest conditions (MFC) growing adjacent to various stream channel sizes and elevation zones using the View-to-the-Sky (VTS) model as discussed in Appendix 9-2. Reference conifer, mixed and hardwood tree heights were modeled using 100-year site potential tree growth for the ecoregions encompassing the watershed.

As shown in Figure 3-1, Benda and Dunne (1997) predicted the historical forest age-class distribution for the Nehalem watershed based on natural disturbance regimes (fire, landslides, debris flows, etc.). Over thousands of years, they estimated an average of 16 percent of the area would have consisted of forests less than 50 years old and 30 percent would have been less than 100 years old. Mature forest conditions (MFCs) are generally regarded to initially develop around 80 years. Based on the Benda and Dunne (1997) assessment, one could assume MFC and older stands were likely prevalent across approximately 75 percent of the watershed area, on average, over time.

Openings in the riparian canopy and the influence of varying vegetation ages to simulate the effect of occasional disturbance regimes, were modeled using the effective tree height option in the VTS model to account for a reduction in stand opacity. This approach was included to provide potential variability and ranges to surface water temperatures that may have occurred historically. The resulting thermal regimes were assumed to represent reasonably achievable surface water temperatures consistent with historical conditions under occasional disturbances in mature forest conditions (Chapter 9 and summarized in Table 11-9). Given the adaptation of aquatic biota over time to local thermal conditions, the aforementioned reference conditions were regarded as properly functioning conditions (PFC) for streams on ODF lands in the upper Nehalem watershed.

Modeled stream temperatures based on current riparian conditions were also estimated using the VTS model and compared to the reference conditions. The likelihood of exceeding PFC was ranked on relative probability basis as discussed below. Actual stream temperature monitoring data in the watershed were used to verify the model was performing within expected ranges.

Water temperatures were recorded at 12 stations on large and medium stream channels adjoining ODF lands in the Upper Nehalem watershed (DEQ LASAR database). Continuous temperature monitors were installed at eight (8) of the 12 stations where a peak summer 7-day maximum

average could be calculated. The remaining four stations were field spot measurements of surface water temperatures. The monitoring data, specific to ODF lands, are shown in Table 11-8. These data are compared in the table with predicted summer surface water temperatures based on current channel size, elevation and riparian canopy closure levels and reasonably achievable surface water temperatures based on mature riparian timber growing along the water courses (as developed in Assessment Chapter 9, Water Quality).

The recorded 7-day maximum temperatures ranged typically between 12.9ºC and 16.4ºC. The only exception was a 7-day maximum level of 23.9ºC recorded in Fishhawk Creek, 275m (300 yd) downstream of Fishhawk Lake (Sta # 24964 in the Fishhawk Management Basin) during the summer of 2000. The Fishhawk Creek station showed the effect of the shallow reservoir impoundment on downstream water temperatures, which overshadowed the influence of riparian shade. Without the reservoir temperature predictions for this reach, based on the distance from divide (9.8 miles), indicated the reach in Fishhawk Creek along ODF lands had the capability to reasonably achieve 17.7ºC. The current water temperature situation in Fishhawk Creek, downstream of Fishhawk Lake to the confluence with the Nehalem River, was regarded as limiting the ability of aquatic habitats to achieve properly functioning conditions for aquatic habitats.

Summer spot measurements of water temperature at four stations on ODF lands in the watershed, including Lousignont Creek in the Forest Grove District and Gilmore Creek in the Astoria District, ranged between 10.6ºC and 13.1ºC (Table 11-8). These measurements did not represent the full range of summer temperatures experienced in the creeks and were not used in the analysis.

In lieu of monitoring data, the water temperature assessment used current riparian stand characteristics (Part 1: Assessment, Chapter 6, Riparian/Wetlands), channel size, elevation and distance from the divide to predict anticipated stream temperatures on a reach by reach basis. The existing temperature predictions for ODF lands were mapped (Figure 9-2).

Table 11-8. Measured versus predicted surface water temperatures on ODF lands in the Upper Nehalem Watershed. DEQ:LASAR Monitoring Stations List (Parameter: Surface Water Temperature).

Station ID	Location Description	Latitude	Longitude	ODF Lands (Y/N)	Elev. (ft. msl)	Water Type (L,M,S)	Est. Mean BFW (ft)	Riparian Code[1/]	Est. VTS (%)	Summer Temperature Stations: Grab Samples (N)	Temp. Range (°C)	Temp. Mean (°C)	7-day Max (°C)	VTS[2/] Pred. Temp. (°C)
Upper Nehalem														
Wheeler Management Basin														
11843	Lousignont Creek @ RM 7.0	45.7340	123.3388	Y	1040	L	40	HMD	16.8	1	11.0	11.0		15.5
18783	Lousignont Creek Tributary w/in Landslide	45.7236	123.3511	Y	1375	M	20	HMD	8.6	1	13.1	13.1		14.4
17155	Lousignont Creek Tributary upstream of Landslide	45.7236	123.3530	Y	1398	M	20	HMD	8.6	1	11.2	11.2		14.4
23592	Nehalem River - SF Nehalem @ Cochran Rd.	45.7135	123.3910	Y	1503	M	20	MMD	7.6	4393	8.0 - 13.2	10.7	12.9	14.1
23591	Nehalem River just upstream of SF Nehalem River	45.7140	123.3910	Y	1496	L	40	HMD	16.8	4007	8.4 - 14.5	11.3	14.1	14.8
23273	Nehalem River @ Cochran Rd. Bdg 1393	45.7073	123.3197	Y	1014	L	40	HMD	16.8	4093	9.2 - 17.2	12.8	16.4	16.9[3/]
McGregor Management Basin														
23589	Rock Creek - SF Rock Creek @ HWY 26	45.7938	123.4572	Y	1434	L	40	MMD	15.1	4009	8.3 - 14.3	11.1	13.7	14.8
13265	Tributary to NF Wolf Creek @ RM 0.45	45.7947	123.3837	Y	1139	M	20	CMD	7.6	1128	10.1- 15.5	12.4	14.7	14.7
Quartz Management Basin														
23588	Rock Creek @ HWY 26 upstream of SF Rock Creek	45.8044	123.4737	Y	1381	L	40	CMD/SHR	37.1	4009	8.4 - 17.2	12.8	16.3	16.5
Middle Nehalem														
Fishhawk Management Basin														
24964	Fishhawk Cr. 300 yds downstream of Fishhawk Lake	46.0288	123.3677	Y	538	L	40	HMD	16.8	1880	15.9 - 25.2	19.6	23.9	17.7[3/]
Northrup Management Basin														
24976	Northrup Cr. At Headwaters	46.0366	123.4386	Y	850	M	20	CSD/CRD	26.9	2179	7.0 - 17.1	12.5	16.3	16.6
Lower Nehalem														
Beneke Management Basin														
29937	Gilmore Cr. Tr.	45.9601	123.5329	Y	768	M	20	MMD	7.6	1	10.6	10.6		15.2

1) Riparian Code defined in Table 6-2.
2) VTS = View-to-the-Sky Temperature Assessment Model (WFPB 1997)
3) Predicted per distance from divide temperature regression (Biosystems et al. 2003)

ODF Temperature Prediction Summary

Frequency	Percent	Comment
2	29%	Slightly cooler; within - 10% of measured mean temperature (1434 - 1500 ft msl)
5	71%	Predicted temperatures fall within ± 5% of measured mean (850 to 1496 ft msl)
0	0%	Slightly warmer; within + 10% of measaured mean temperature
0	0%	Much warmer; > 10% of measured mean tempreature
1		Lake Outflow; reservoir influence

The likelihood of water temperatures limiting the ability of a stream reach to achieve PFC was assessed based upon reasonably achievable temperatures modeled under MFC for low elevation streams in each management basin (Table 11-9).

Table 11-9. Reasonably Achievable Water Temperatures at the lowest stream elevation in each Management Basin on ODF lands.

Basin	Elevation (ft, msl)	Channel Size	Distance from Divide (mi)	Reasonably Achievable Temperature ºC
Astoria				
Beneke	541	Moderate	< 3.8	<16.0
Buster	423	Large	7.0	17.1
Crawford	472	Moderate	< 3.8	<16.0
Fishhawk	528	Large	9.8	17.7
Hamilton	666	Large	4.0	16.1
Lousignot	515	Large	< 3.8	16.0
Northrup	518	Large	7.0	17.1
Quartz	315	Moderate	4.3	16.4
Sager	495	Large	4.0	16.1
Forest Grove				
McGregor	883	Large	4.3	16.3
Wheeler	833	Large	10.2	17.8
Wilark	764	Large	< 3.8	<16.0

The current riparian conditions were then compared to reasonably achievable temperatures (PFC) and the likelihood of exceeding PFC was ranked on a low, moderate and high level of probability. Summer 7-day maximum temperatures predicted to exceed 20ºC were rated as a high likelihood to limit the ability of a stream reach to achieve PFCs. Temperatures predicted to comply with the reasonably achievable temperatures in each basin were rated with a low likelihood to be limiting. Intermediate situations were rated with a moderate temperature limitation (Table 11-10).

11.3.1 Astoria District

Approximately 90 percent of the fish-bearing stream miles on Astoria District lands in the study area were rated with low temperature probability to be limiting aquatic life (Figure 11-4). A total of 9 and 1 percent of the fish-bearing stream miles were rated with moderate and high

probabilities to be limiting, respectively. As shown in assessment Figures 9-2a,b through 9-4a,b and Table 11-10, Beneke, Buster, Fishhawk, Hamilton and the Northrup Management Basins all comprised greater than 95 percent of the stream miles in the low probability category. The Lousignot Management Basin currently supports the lowest percentage (54%) of fish-bearing stream miles in the low probability category, offering 46 percent of the stream miles in the moderate probability category. Compared to the other basins in the Astoria District, the Quartz Management Basin had the greatest percentage (5%) of stream miles (0.7 miles) in the high probability category (Figure 11-3a,b).

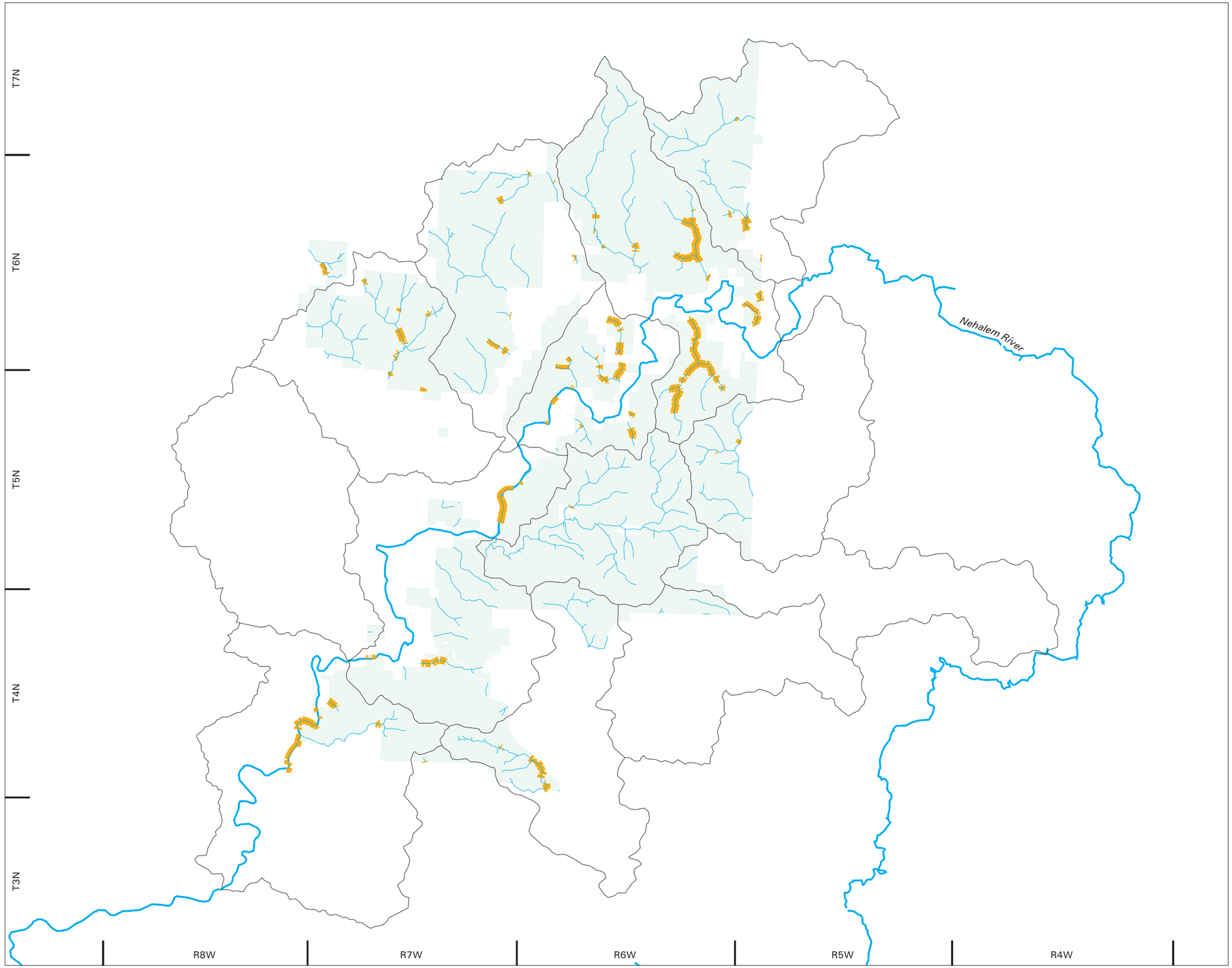
11.3.2 Forest Grove District

Approximately 96 percent of the fish-bearing stream miles on Forest Grove lands in the study area, are currently rated with low probability, while 4 percent were rated with a moderate probability that water temperatures are limiting the ability of a stream reach to achieve properly functioning conditions (Figure 11-5). A total of 0.4 stream miles (0%) were rated in the high probability category. As shown in Figure 11-3a,b and Table 11-4, McGregor, Wheeler and the Wilark Management Basins all comprised greater than 90 percent of the stream miles in the low probability category. The McGregor Management Basin currently supports the highest percentage (10%) of fish-bearing stream miles (6.3 miles) in the moderate probability category, compared to the other basins in the District.

11.3.3 Stream Temperature Conclusion

Stream reach-level water temperatures were estimated for ODF lands in the upper Nehalem Watershed based on various channel sizes, elevations, riparian stand conditions and distances from the topographic divide in each subbasin. Properly functioning habitat conditions (PFC) for water temperature were assessed in accordance with reasonably achievable water temperatures based on mature forest conditions and an allowance for openings in riparian canopies as a function of typical historical channel disturbance regimes (Benda and Dunne 1997).

The current riparian situations on ODF lands in the watershed are anticipated to meet PFC along 93 percent of the fish-bearing streams in the watershed. Approximately 17 miles and 2 miles of ODF fish-bearing streams are anticipated to have a moderate and high risk of limiting the achievement of PFC, respectively.

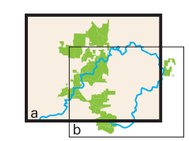


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



N

1 Inch = 2.7 Miles

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Miles

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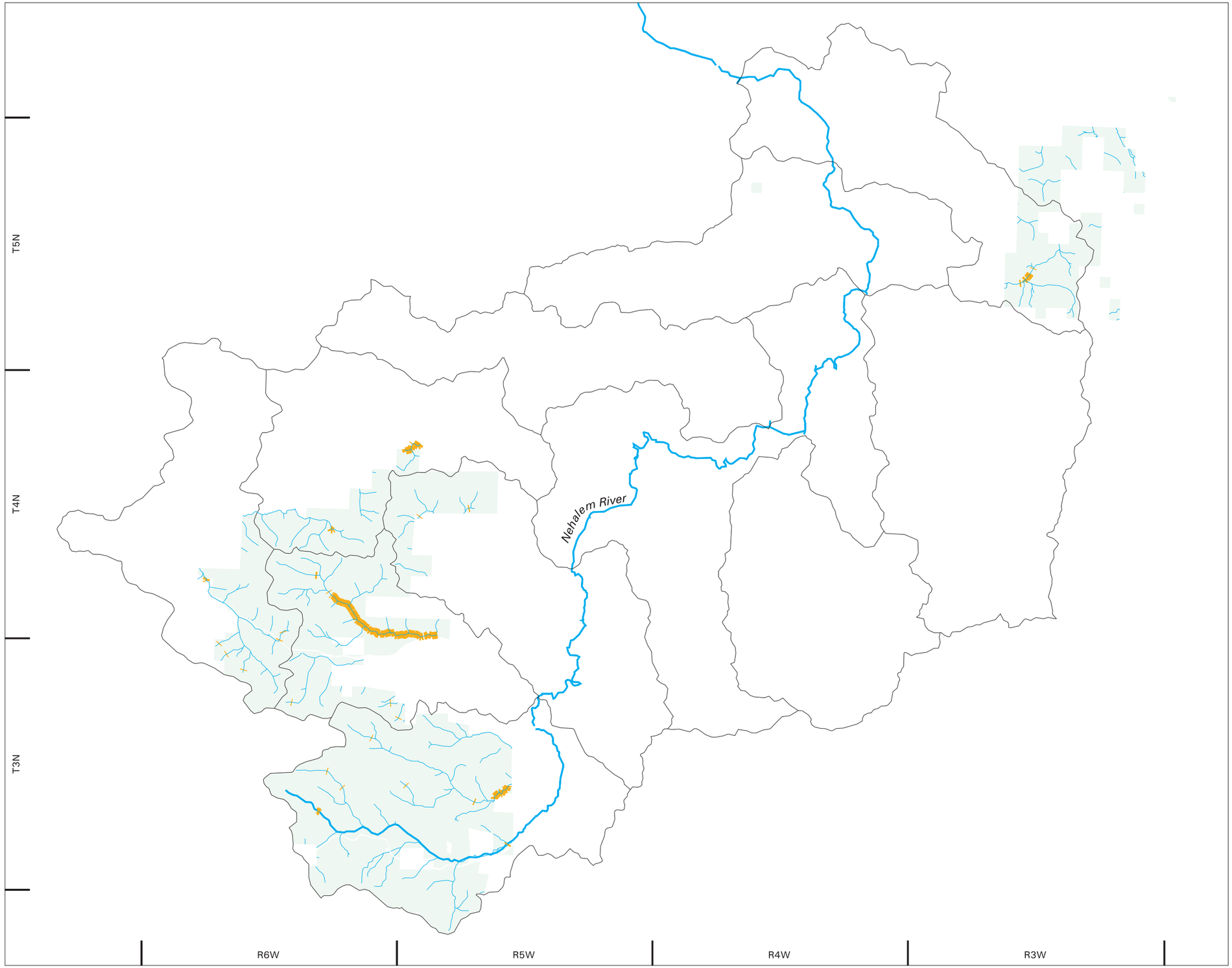
Upper Nehalem Watershed Analysis

Figure 11-3(a)

Predicted Risk to Achieving PFC for Water Temperature

Astoria District

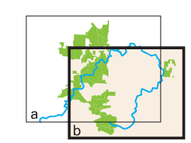


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



N

1 Inch = 2.3 Miles

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Miles

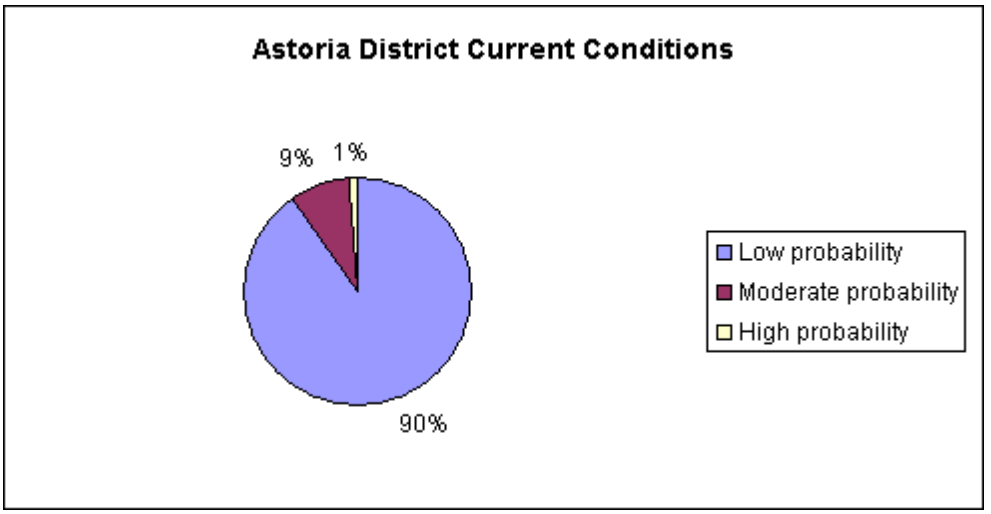
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

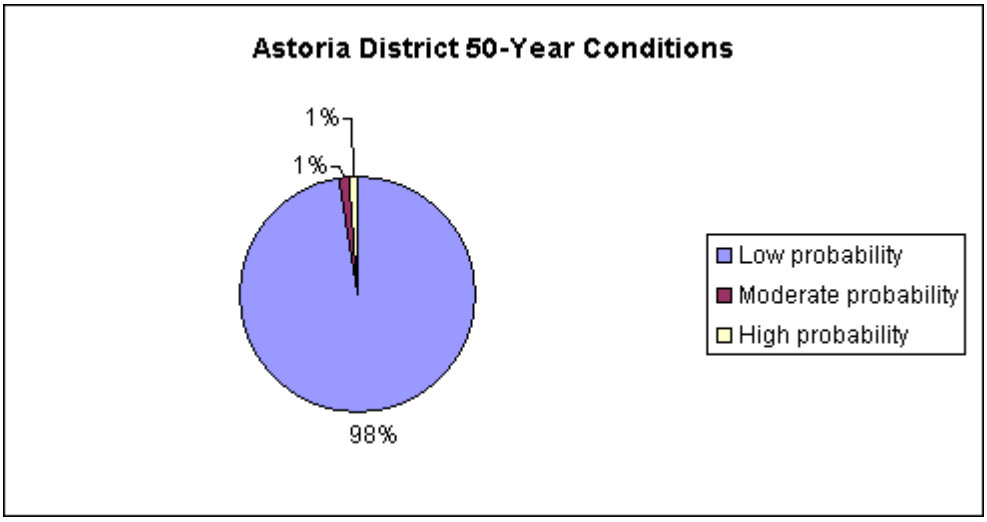
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-3(b)

Predicted Risk to Achieving PFC for Water Temperature

Forest Grove District





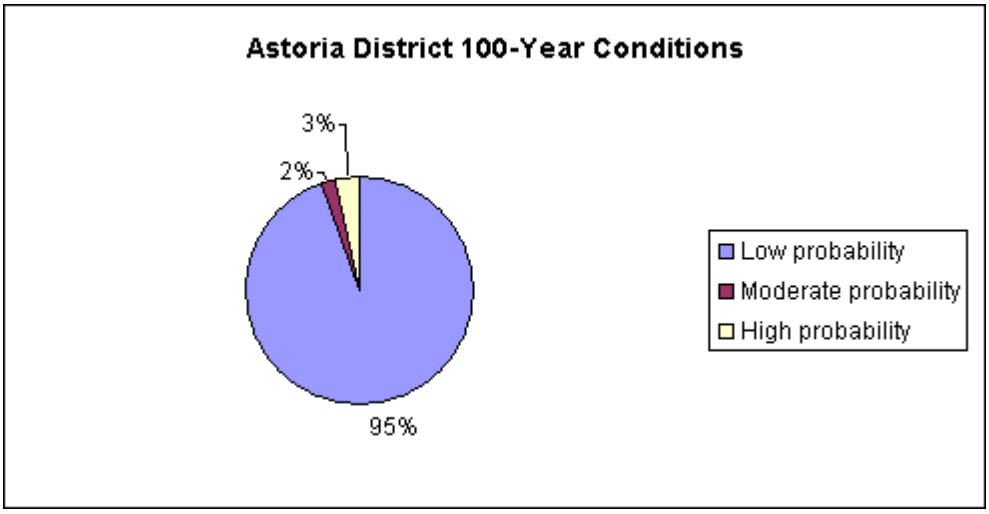
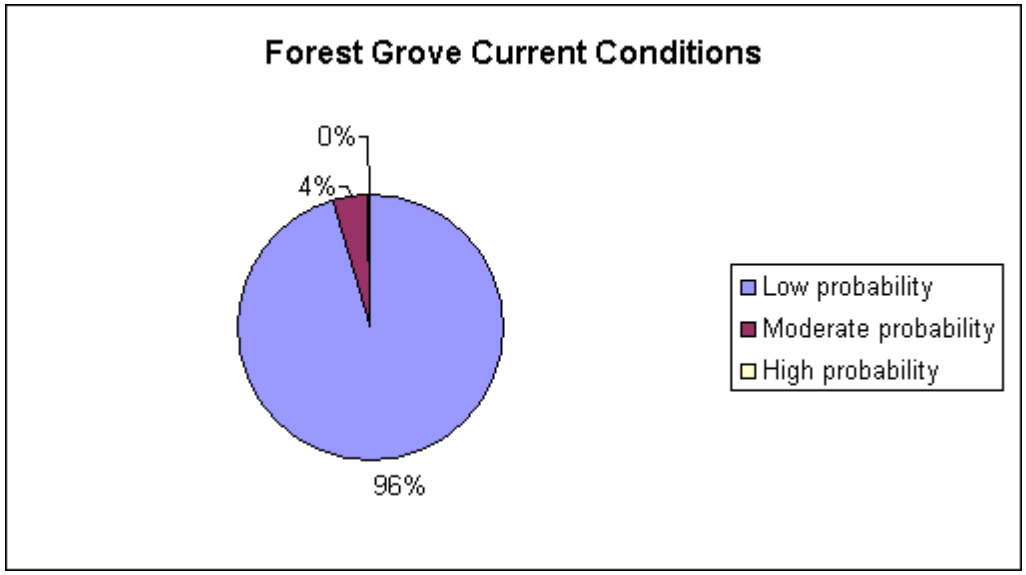


Figure 11-4. Likely probability that riparian shade conditions limit the potential for water temperatures to achieve properly functioning levels along fish-bearing streams on Astoria District lands in the upper Nehalem Watershed



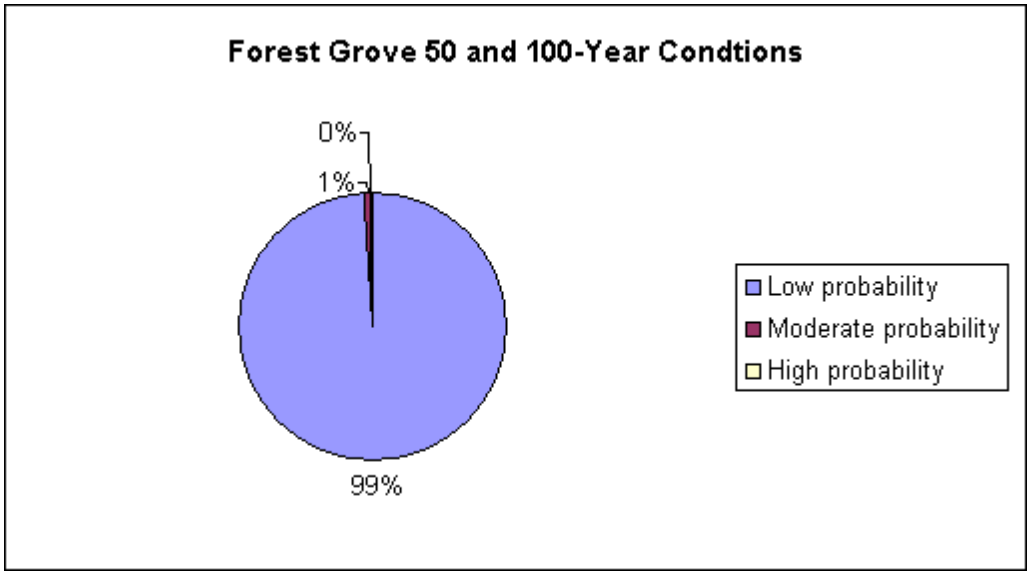


Figure 11-5. Likely probability of riparian shade conditions to limit the potential for water temperatures to achieve properly functioning levels along fish-bearing streams on Forest Grove District lands in the upper Nehalem Watershed.

The most amount of stream miles per subbasin with either a moderate or a high risk of limiting habitat conditions for aquatic life were determined as follows:

Management Basin	Stream Miles	Percent of Subbasin
Sager	4.5	24%
McGregor	3.5	10%
Lousignot	3.4	47%
Quartz	2.8	20%
Crawford	1.9	34%

Of these five basins, only the Lousignot and Crawford Management Basins exceeded, and the Sager Management Basin approaches, a predicted forest-age distribution of stands less than 80 years old (<25%) based on typical Oregon coast range disturbance regimes (Benda and Dunne 1997). It was assumed at any one point in time, riparian stands younger than a mature forest condition would pose a risk to achieving PFC.

11.4 OTHER LIMITING FACTORS

No other conditions related to forest management practices were identified in the assessment with the potential to limit the achievement of properly functioning aquatic habitat conditions on ODF lands in the Upper Nehalem Watershed.

Table 11-10. Likely probability existing surface water temperatures in ODF Management Basins are limiting the ability of a stream reach to achieve properly functioning aquatic habitat conditions.

Limiting Condition	ODF Management Basins in Forest Grove District									
	McGregor					Wheeler				Wilark
Probability	171002020102	171002020103	171002020105	171002020106	Total	171002020101	171002020102	171002020105	Total	Total
Low ≤ pfc	79%	100%	100%	97%	89.8%	98%	100%	100%	99.0%	99.0%
Moderate	21%	0.3%	0.1%	2.4%	10.1%	1.2%	0.2%	0.1%	0.9%	0.0%
High > 20C	0%	0.0%	0.2%	0.2%	0.1%	0.3%	0.0%	0.2%	0.2%	0.8%
Stream Length (mi)	13.9	4.2	4.2	9.2	31.4	35.7	5.8	7.8	49.3	6.2

	ODF Management Basins in Astoria District									
	Beneke	Buster						Crawford		
	Total	171002020105	171002020106	171002020107	171002020304	171002020305	Total	171002020301	171002020302	Total
Low ≤ pfc	97%	100%	100%	100%	100%	100%	100%	64%	100%	65%
Moderate	3%	0%	-	-	0%	0%	0%	35%	-	33%
High > 20C	1%	-	-	-	0.3%	0.1%	0.2%	1%	-	1%
Stream Length (mi)	18.7	3.6	1.8	0.7	30.0	8.5	44.4	5.3	0.2	5.5

	ODF Management Basins in Astoria District									
	Fishhawk	Hamilton			Lousignot			Northrup		
	Total	171002020303	Young's Bay	Total	171002020205	171002020208	Total	171002020208	171002020302	Total
Low ≤ pfc	99%	95%	100%	96%	70%	50%	54%	95%	92%	95%
Moderate	0.3%	4%	-	4%	29%	49%	46%	2%	8%	2%
High > 20C	0%	0.5%	-	0.5%	1%	0.4%	0.5%	2%	-	2%
Stream Length (mi)	10.6	16.7	1.7	18.4	1.3	6.2	7.4	13.5	0.4	13.8

	ODF Management Basins in Astoria District									
	Quartz					Sager				Scattered
	171002020105	171002020305	171002020307	171002020402	Total	171002020206	171002020208	171002020301	Total	Total
Low ≤ pfc	79%	80%	83%	82%	80%	99%	45%	84%	77%	44%
Moderate	12%	19%	16%	18%	15%	0.5%	53%	16%	23%	53%
High > 20C	9%	1%	1%	-	5%	0.1%	1%	-	1%	2%
Stream Length (mi)	6.2	2.7	4.9	0.1	13.8	9.1	7.2	2.5	18.7	0.2

12. ALTERNATIVE VEGETATIVE MANAGEMENT

The following questions were addressed in this chapter to help identify where management standards are likely or unlikely to achieve properly functioning aquatic habitat conditions (PFC). If suitable riparian conditions were not likely to be met in a timely fashion, alternative vegetative management were suggested to achieve PFC.

1. *Given current management strategies, which sub-watersheds have aquatic and riparian conditions that have already achieved the PFC?*
2. *Which sub-watersheds have aquatic and riparian conditions suitable for the development of the PFC in a 50-yr timeframe? In 100-yr timeframe? Longer than a 100-year timeframe?*
3. *For those sub-watersheds where it will take longer than 100 years to develop the PFC, prioritize by stream reach (and map) for alternative vegetation management to achieve the PFC.*

PFC was evaluated for two discrete habitat attributes related to riparian stand conditions; (1) large wood recruitment potential and (2) shade/water temperature in the following sections. All three of the key alternative vegetation management questions were addressed below for both the large wood recruitment and shade attributes.

12.1 LARGE WOOD RECRUITMENT POTENTIAL

The objective for defining PFC for the potential wood recruitment from riparian management stands to stream channels is to achieve reasonable stand conditions comparable to unmanaged lands under late-successional, mature forest conditions (MFC; 80 to 200 years). The earliest a fully-stocked, unmanaged stand would generally achieve an average relative conifer stand size of 24 in. mean dbh on high level site class soils (Site Index 190) is around 100 years from stand initiation (McArdle et al. 1949). Under less productive site indices for the area, it could take 150 to 200 years to achieve a mean conifer stand diameter of 24 inches dbh. The variability of site conditions along riparian areas in the upper Nehalem watershed make generalizations difficult; however, it is possible some of the low elevation riparian soil conditions would not naturally produce the OWEB reference vegetation condition of CLD or MLD (greater than 24 in. DBH) within 80 to 100 years without silvicultural management.

In establishing reference conditions for wood recruitment potential, it is also important to emphasize the typical riparian conditions under natural Oregon Coast Range disturbance regimes. Over the long-term, the historic forest was estimated to support forest stand-age class conditions of less than 80 years old across 25 percent of the Nehalem watershed area at any point in time (refer to Chapters 3 and 7 after Benda and Dunne 1997).

Therefore, two separate techniques for evaluating PFC for wood recruitment potential were used herein:

1. the frequency of stand conditions consistent with OWEB (1999) reference criteria for RA1 of hardwood, mature, dense stands (HMD) and for RA2 of either conifer or mixed-species, large, dense stands (CLD or MLD), and
2. WFPB (1997) guidelines for potential wood recruitment levels.

Both techniques are described below:

(1) OWEB (1999). Riparian areas comprised of HMD vegetation conditions represent densely-stocked stands dominated by deciduous species (< 30% conifer composition) between 12 to 24 inches in diameter that range in age between approximately 50 and 99 years. The hardwood species may dominate the low level terrace zone adjacent to stream channels (RA1) due to the prevalence of saturated soil conditions and highly disturbed nature of channel processes. These stand conditions were deemed the normal reference situation for the Ecoregions in the watershed. Although hardwood-dominated stands were prevalent along the riparian edges, and accounted for 27 percent of the length along stream channels adjacent to ODF lands in the watershed. Only 16 percent of the stands were sufficiently large and dense to be consistent with the OWEB reference condition of HMD. This situation was similar among both the Astoria and Forest Grove Forest Districts. The Beneke and Hamilton Management Basins in the Astoria District supported the highest frequency of stream miles (39% each) consistent with HMD riparian conditions.

Densely stocked conifer-dominated or mixed species stands in excess of mean stand diameters of 24 inch dbh (CLD, MLD) represented the OWEB reference conditions for the riparian hillslope areas (RA2) where soil conditions were drier and the influence of channel disturbances were less than in the terraces areas. These stands represented densely-stocked mixed and conifer-dominated species compositions that ranged under unmanaged conditions between 100 and 200 years in stand age depending upon soil productivity. Silvicultural thinning regimes can produce

mean conifer or mixed-species stand diameters of 24 in. in perhaps 80 years on the best site classes.

None of the HUCs or Management Basins currently support mean stand sizes of large wood in excess of 24 inch dbh. Sufficient time has not occurred since legacy harvests and fires altered the overall stand age distributions in the watershed. However, many existing stands were approaching this size class as discussed below.

(2) (WFPB 1997). Washington state guidelines for conducting watershed analyses accept a broader range of riparian stand conditions appropriate for in-channel wood loading than the OWEB approach. The difference is based on the direct relationship between functional wood sizes and channel size. Using literature data for functional wood piece diameters for variable sized channels (Bibly and Ward 1989; Beechie and Sibley 1997; Beechie 1998; and Kennard et al. 1999; Table 12-1), the WFPB (1997) concluded riparian code conditions CLD, MLD, CMD and MMD provided a high level and CMS, MMS and HMD provide a moderate level of wood recruitment potential for channels the size of small, medium and large streams in the upper Nehalem watershed.

For this watershed analysis, the OWEB guidelines were used to represent "*reference riparian stand conditions*" and the WFPB guidelines were used to represent the near-term large wood "*recruitment potential*." The anticipated distribution of these specific riparian conditions across the landscape were assumed based on the disturbance history work of Benda and Dunne (1997) as shown in Table 12-2. The current riparian stand data are also summarized in Table 12-2 to provide an indication of riparian stand conditions that have met the reference conditions and/or are likely providing a current level of high, medium and low wood recruitment potential to local streams.

12.1.1 Sub-Watersheds That have Achieved PFC for Large Wood.

Overall the current riparian conditions on ODF lands in the Upper Nehalem watershed offered 53, 19, 28 percent of the total stream miles in high, moderate and low wood recruitment categories, respectively (Table 12-2). Approximately, 16 percent of the inner riparian terrace (RA1) zone (38.7 stream miles) was consistent with the OWEB reference "Hardwood Mature Dense" (HMD) condition, while none of the outer riparian hillslope (RA2) zone was mature enough to meet the "Conifer or Mixed-Species Large Dense" (CLD or MLD) reference condition. The situation in RA2 was a result of legacy harvests in this zone and insufficient time to

Table 12-1. Review of available literature regarding functional wood diameters in various channel sizes.

Channel Class	Channel Size[1/]		Beechie (1998)		Beechie-Sibley (1997)		Bilby-Ward (1989)		Kennard et al. (1999)		Range of Estimates
			Minimum Diameter		Minimum Diameter		Min. Mid-point Diam.		Min. DBH Diameter		
	mean (acw)		LWD	LWD	LWD	LWD	LWD	LWD	LWD	LWD	LWD
	(m)	(ft)	(cm)	(in)	(cm)	(in)	(cm)	(in)	(cm)	(in)	(in)
Mainstem	23.0	75	187.5	73.8	210.6	8.0	75.7[3/]	29.8[3/]	251.6	17.1	23 - 36
Large	9.1	40	100.0	39.4	112.6	3.3	112.0	12.7	144.5	12.0	9 - 23
Medium	6.1	20	50.0	19.7	56.6	2.3	69.2	12.0	83.3	10.9	6 - 16
Small	2.5	10	10.0[2/]	4.0[2/]	10.0[2/]	4.0[2/]	31.8[3/]	13.0[3/]	52.7	9.6	4 - 13

1) = approximate average of ODFW surveyed AIP data from streams in the upper Nehalem watershed.

2) = Minimum LWD diameter size defined as a 10 cm (4 inch) diameter log.

3) = Extrapolated beyond range of field data

Beechie and Sibley (1997)

Min. LWD diameter$_{(cm)}$ = 2.8(CW_m) + 0.57

Min. LWD diameter$_{(in)}$ = 0.336(CW ft)+0.2244

Beechie (1998)

Min. LWD diameter$_{(cm)}$ = 2.5(CW_m)

Min. LWD diameter$_{(in)}$ = 0.3(CW ft)

Bilby and Ward (1989)

Min. LWD diameter$_{(cm)}$ = 2.14(CW_m) +26.43

Min. LWD diameter$_{(in)}$ = 0.2568(CW ft)+10.406

Kennard et al. (1999)

Min. LWD diameter$_{(cm)}$ = 3.06(CW_m) +22.1

Min. LWD diameter$_{(in)}$ = 0.367(CW ft) + 8.7

Table 12-2. Projected frequencies of riparian recruitment categories 50 and 100-yr. in the future adjusted for long-term likelihood of channel disturbances.

		Current			**50-Yr.**			**100 - Yr.**			**Reference**
Reference Stand Condition (OWEB 1999)											
Riparian Zone	Riparian Code	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	Stand with Natural Disturbances[1/]
RA1	HMD	16%	15%	17%	27%	33%	23%	16%	16%	16%	43%
RA2	CLD, MLD	0%	0%	0%	42%	48%	38%	67%	63%	70%	70%
Large Wood Recruitment Potential (WFPB 1997)											
Recruit. Potential	Riparian Code	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	
High	CLD, MLD, CMD, MMD	53%	53%	53%	60%	56%	63%	67%	63%	70%	70%
Moderate	CMS, MMS, HMD	19%	18%	20%	26%	32%	22%	18%	18%	18%	14%
Low	All other riparian codes:	28%	29%	27%	14%	12%	15%	15%	19%	12%	16%

1) after disturbance rates developed in Benda and Dunne (1997) for western Oregon Coast Range watersheds the size of the upper Nehalem by correlating riparian codes and forest age-classes.

grow trees where the average stand size exceeded 24 in dbh. The Wolf Creek fire may have contributed to the intermediate-aged riparian stand conditions in the Quartz and McGregor Management Basins.

12.1.1.1 Current Conditions

None of the 6th field HUCs or Management Basins currently supported riparian conditions that offer relative stand sizes of large wood in excess of 24 in. DBH. These results are consistent with the general finding of limited wood levels in ODF streams (Kavanagh et al. (2005) and the abundance of reaches where in-stream loading of key piece-sized wood were low (Figure 11-1a,b). Nevertheless, the current potential for wood recruitment was rated high along more than 60 percent of the fish-bearing waters in the Fishhawk, Buster and Wilark Management basins, since a number of dense conifer or mixed stands were approaching the large wood size category. More than 94 percent of the stream reaches in the Beneke Management basin were rated with either a high or moderate recruitment potential. Based on the estimated natural historic distribution of stand characteristics supporting high, moderate, and low recruitment potential for large wood, the fishhawk management basin in the project area is currently consistent with PFC. Basins with the least amount of either a high or a moderate recruitment potential included Northrup, Sager, Crawford and McGregor.

12.1.2 Sub-Watersheds with Suitable Conditions for the Development of PFC for Large Wood in 50, 100 and More Than 100 Years in the Future

12.1.2.1 50-Year Time Frame

Many of the riparian zones adjacent to fish-bearing waters in the watershed appeared to be on a trajectory to PFC and should achieve such conditions within a 50-year time frame under proposed management strategies for aquatic and riparian areas. The two principal riparian management strategies include the *Northwest Oregon State Forest Management Plan (NW FMP)* and the "Salmon Anchor Habitats (SAHs) Strategy for Northwest Oregon State Forests" (ODF 2003). The NW FMP specifies for all fish-bearing streams: (1) no-harvest within the 0 - 25 ft streambank zone and (2) silvicultural management within the inner 25- to 100 ft-zone to achieve mature forest condition (MFC) equivalent to stand ages of 80 to 100 years or greater with stand structure targets of 220 ft^2/acre conifer basal area, a stand density index of greater than 25% SDI; and at least 50 TPA with 40 – 45 conifer TPA > 32 in. DBH (ODF 2001).

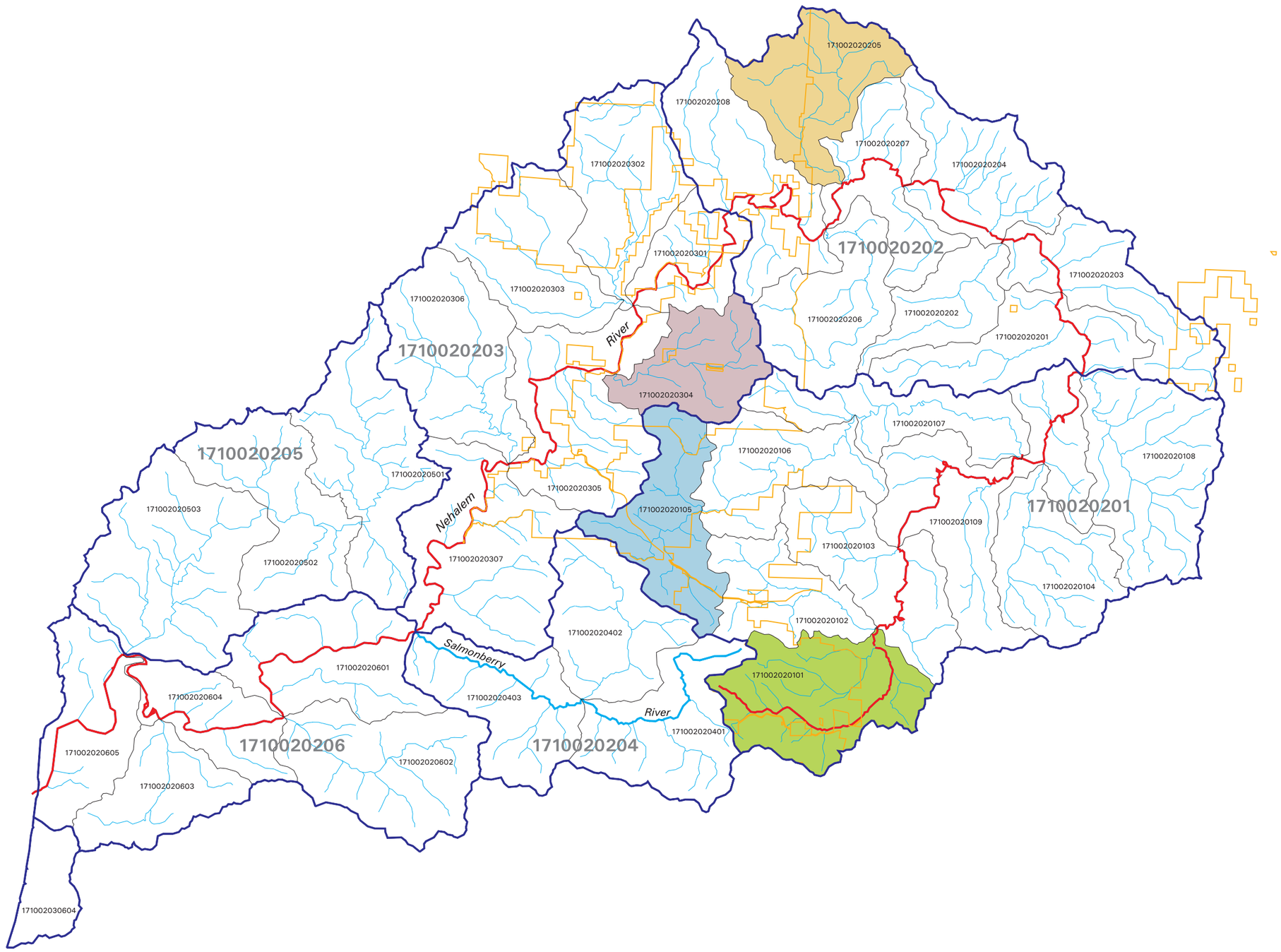
The NW FMP also identified specific SAH strategies for managing core watershed areas potentially representing metapopulations of salmonid fish species. The SAH strategy is intended

to represent lower short-term risk to populations of key salmonid species (metapopulations; core-areas) on state forests than the NW FMP for a period of 10-years, until June 30, 2013.

ODF has designated the mainstem Nehalem River and four HUCs in the upper Nehalem Watershed area as SAHs (Figure 12-1) as follows:

Buster Cr.	#171002020304
Fishhawk Cr.	#171002020205
Lousignont Cr.	#171002020101
Upper Rock Cr.	#171002020105

Differences between management operations in the NW FMP and in the SAHs are highlighted in Table 12-3. There are differences with respect to riparian forest management in NW FMP Strategies 2, 3, and 4; to sediment delivery in both Strategy 6 "Slope Stability" and Strategy 7 "Forest Roads Management" of the FMP. The primary difference with respect to riparian areas for fish-bearing streams is the SAHs specify a 100 ft no-harvest zone (NHZ) throughout the entire inner riparian zone.



Legend

- Buster Creek (SAH)
- Fishhawk Creek (SAH)
- Lousignont Creek (SAH)
- Upper Rock Creek (SAH)
- Nehalem River Mainstem
- Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Map Key

Oregon

N

1 Inch = 4 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-1

Salmon Anchor Habitats

Nehalem River Basin

Table 12-3. Management measures for specific SAHs in the upper Nehalem Watershed

Strategy 2; Aquatic and Riparian Areas

Fish-bearing and Large and Medium Non-Fish bearing streams:

- All harvest activity

  0 - 100 ft. No-harvest zone (NHZ)

  No more than 10% vegetation disturbance in RMAs for cable corridors or felling impacts

Small, Non-Fish bearing, perennial streams:

- Partial cuts retaining > 25% SDI:

  0 - 50 ft. (Ground-based) ELZ

- Any harvest activity reducing density < 25% SDI:

  0 - 50 ft. NHZ

  50 – 100 ft. 15 – 25 TPA conifer tree or snag retention

- No more than 25% vegetation disturbance in RMAs for cable corridors or felling impacts

Small, Non-Fish bearing, seasonal streams:

- Partial cuts retaining > 25% SDI:

  0 - 50 ft. (Ground-based) ELZ

- Any harvest activity reducing density < 25% SDI:

  0 - 50 ft. (Ground-based) ELZ

  0 - 50 ft. 15 – 25 TPA conifer tree or snag retention

- High Energy Reaches and Potential Debris Flow Track Reaches that are direct tributaries to Fish-bearing streams

  0 – 50 ft. NHZ

- No more than 25% vegetation disturbance in RMAs for cable corridors or felling impacts

Debris Torrent Fans

- No harvest on the fan

Strategy 3, Restore Aquatic Habitats

- SAH watersheds within the District that have been determined to have high restoration potential will be a high priority for implementation
- This aspect will help us set priorities for management actions.

Strategy 4, Alternative Vegetation Treatment

- Use alternative vegetation treatments only where, through analysis, ODF in consultation with ODFW determine the risk to species using the stream in question are less than without the alternative.

Table 12-3. (cont)

Strategy 6, Slope Stability

- Reduce the likelihood of sediment delivery to streams from management-related landslides through closer scrutiny by geotechnical specialists.
- All new road construction in an SAH will be reviewed by a Geotech. For HLHLs and high risks to streams
- Avoid harvest operations and road construction in HLHL that pose a high risk to streams
- Report landslides through inventory procedures and apply adaptive management

Strategy 7, Forest Roads Management

- SAHs priority basins for completing District Transportation plans
- Identify existing and legacy roads needing formal abandonment
- New road construction minimized to lower level of harvest activities
- New road construction limited to upper portions of slopes away from streams
- New road construction designed to avoid perennial stream crossings
- Dry weather construction only
- SAHs high priority for conducting needed road network repairs including unstable sidecast, road drainage, fish passage barriers identified through road inventories
- Correct all problem areas within 10 years
- Existing roads are a high priority for maintenance and improvement to minimize potential sediment delivery to streams
- Dry weather hauling unless prior approval and close monitoring of road surface and drainage systems

Specific SAH Limitations on Timber Harvest Activities

<u>Buster/Lousignont HUCs</u>

- Max. 20% of state forest related to commercial thinning (CT), regeneration harvests (clearcuts) or other timber harvest activity during the 10-year period.
- Of this total, clearcut harvesting shall not exceed 5% of the total acreage in the HUC.
- Clearcut harvesting will not be allowed where the percent of stands ≤ 15 years would exceed 15% of the ODF acreage in the HUC as a result of harvest.

<u>Fishhawk/Upper Rock HUCs</u>

Major waterfalls create natural barriers to fish passage near the state ownerships and fish use is primarily limited to downstream areas from state forests. The primary benefits of state forests shall be to provide downstream effects related to sources of large wood and good water quality.

- No thinning acreage limit
- Clearcut harvesting shall not exceed 7% of the total state forest acreage in the HUC during the 10-year period.
- Clearcut harvesting will not be allowed where the percent of stands ≤ 15 years would exceed 15 % of the ODF acreage in the HUC as a result of harvest.

Reference Stand Conditions: Nearly 42 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (100 miles) were projected to develop sufficient riparian stand characteristics in the next 50 years to generate reference conifer/mixed stand conditions in RA2 for large diameter wood (> 24 in.) in 50 years. Similarly, 27 percent of the ODF fish-bearing stream miles were projected to support riparian conditions consistent with OWEB reference hardwood condition for RA1.

Wood Recruitment Potential*:* With respect to potential wood recruitment in 50 years, approximately 60, 26 and 14 percent of the riparian situations along ODF forest lands adjacent to fish-bearing waters were anticipated under NW FMP and SAHs strategies to offer high, medium and low recruitment potential (WFPB 1997). These trends were similar among both the Astoria and Forest Grove Forest Districts. The McGregor, Wheeler, and Wilark Management Basins in the Forest Grove District and Beneke, Buster, Crawford, Fishhawk, Hamilton, and Lousignot Management Basins in the Astoria District supported the highest frequency of stream miles (86% to 90%) consistent with high and medium potential large wood recruitment conditions. Similarly, Wheeler, Buster and McGregor provided the most total miles in the high recruitment category compared to all twelve of the Management Basins. All of the basins were anticipated to develop more than 84 percent of the stream miles in either high or moderate recruitment categories consistent with the historic frequency of forest age-classes with the exception of Quartz, Sager and Northrup Management Basins in the Astoria District. These basins were anticipated to offer high and medium recruitment potential for large wood along 74 to 82 percent of the fish-bearing waters.

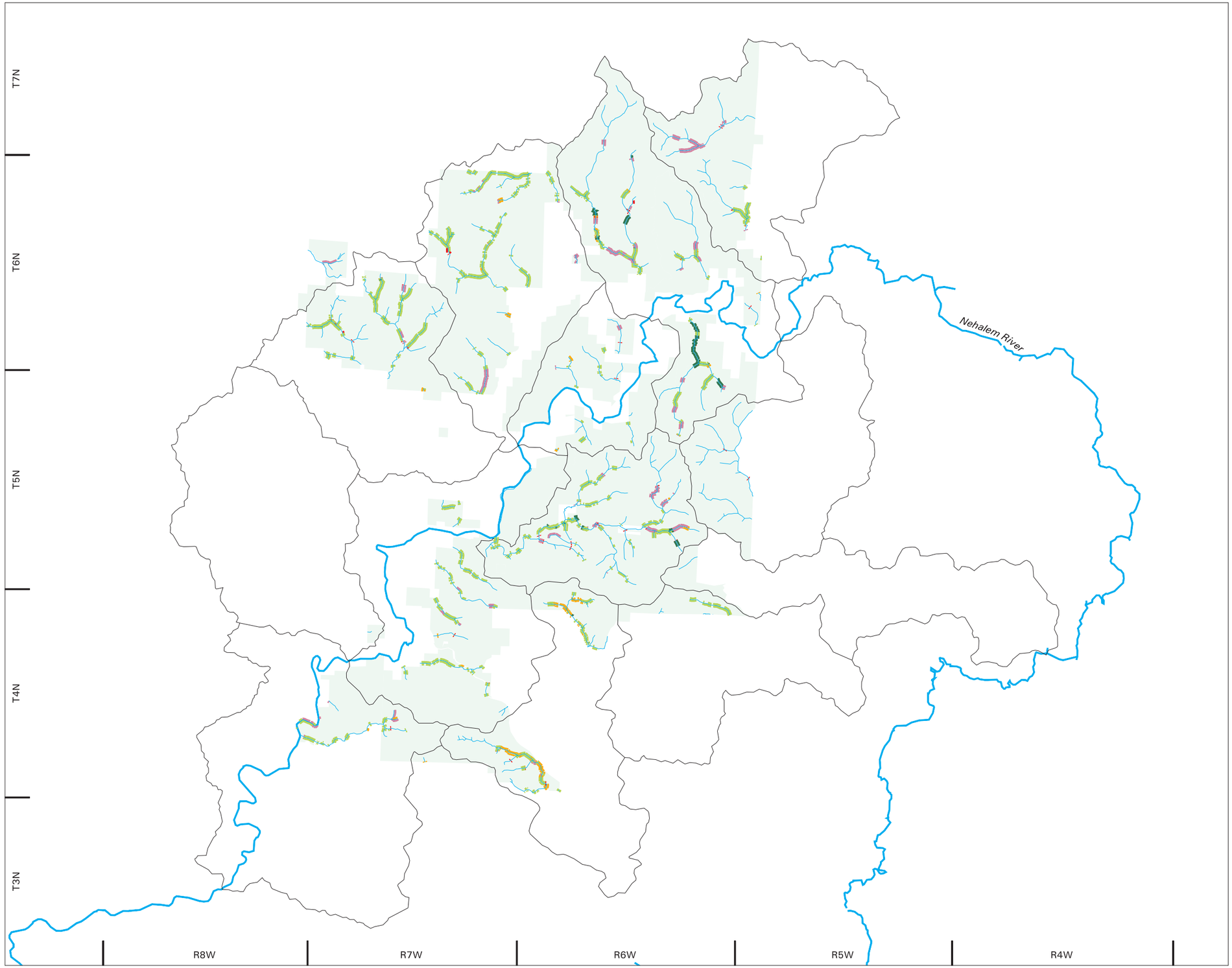
Only 14 percent of the streams adjacent to ODF lands in both Management Districts (34 miles) were projected to remain in a low recruitment potential category in the 50-year time frame. These situations are the primary result of understory conditions precluding the establishment of a second cohort, low densities of some hardwood stands and the influence of ongoing channel disturbances. The Quartz Management Basin was anticipated to have the most stream miles of the Management Basins remaining in a low recruitment category (27%; 3.8 miles).

The riparian situation in a 50-year time frame was projected to offer a distribution of vegetative conditions consistent with natural disturbance regimes along western Oregon coast range streams (Benda and Dunne 1997) for most of the management basins. Low recruitment potential in the Northrup, Sager and Quartz Management Basins along 17 to 27 percent of the fish-bearing stream length in each basin was slightly greater than the anticipated natural variation in frequencies of young forested age-classes (< 50 years) of 16 percent.

12.1.2.2 100-Year Time Frame

Reference Stand Conditions: Approximately 67 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (160 miles) were anticipated to develop sufficient riparian stand characteristics in 100 years to generate PFC for large diameter wood (> 24 in.) in both RA1 and RA2 where mixed and conifer-dominated stands prevail. However, the medium-sized (12 – 24 in.), dense, hardwood-dominated stands (HMD) prevalent in riparian zone RA1 should thin considerably in the subsequent 50-year period due to natural senescence of hardwood trees. These hardwood stands were anticipated to become sparse (HMS or HLS) in 100 years. Unmanaged, hardwood-dominated stands were not anticipated to regenerate a second cohort and both hardwood canopy and shrub understory are anticipated to preclude conifer regeneration within 100 years. Only by means of anticipated future natural stand disturbances, will the existing HMD stands in the RA1 zone maintain some of the OWEB reference condition at 100-years. Based on historic rates of natural disturbance, we anticipated approximately 16 percent of fish-bearing stream length on ODF lands in the upper Nehalem watershed could become disturbed and grow sufficiently to meet reference conditions for RA1.

Wood Recruitment Potential*:* With respect to potential wood recruitment in 100 years, approximately 67, 18 and 15 percent of the riparian situations along ODF forest lands adjacent to fish-bearing waters were anticipated under NW FMP and SAHs strategies to offer high, medium and low recruitment potential (WFPB 1997). These trends were similar among both the Astoria and Forest Grove Forest Districts. The Wilark Management Basin in the Forest Grove District and Fishhawk, and Crawford Management Basins in the Astoria District supported the highest frequency of stream miles (93% to 94%) consistent with high and medium potential large wood recruitment conditions. All of the basins were anticipated to develop more than 84 percent of the stream miles in either high or moderate recruitment categories with the exception of Quartz, Hamilton, and Beneke Management Basins in the Astoria District and McGregor and Wheeler Management Basins in the Forest Grove District. These basins were anticipated to offer low recruitment potential for large wood to fish-bearing waters along 19 to 26 percent of the fish-bearing waters, slightly higher than historic frequencies that likely occurred under natural disturbance regimes. The locations of reaches supporting low wood recruitment potential are shown in Figure 12-2a,b and the areas are prioritized for alternative vegetative management actions in Chapter 16.

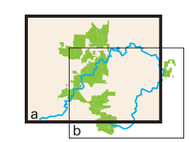


Legend

- 1 - Vegetation Composition
- 2 - Development
- 3a - Sparse Hardwood Species
- 3b - Sparse Conifer and Mixed Species
- 4 - Hardwood Senescence
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Numbers 1-4 indicate recommended alternative vegetation management scenarios.

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

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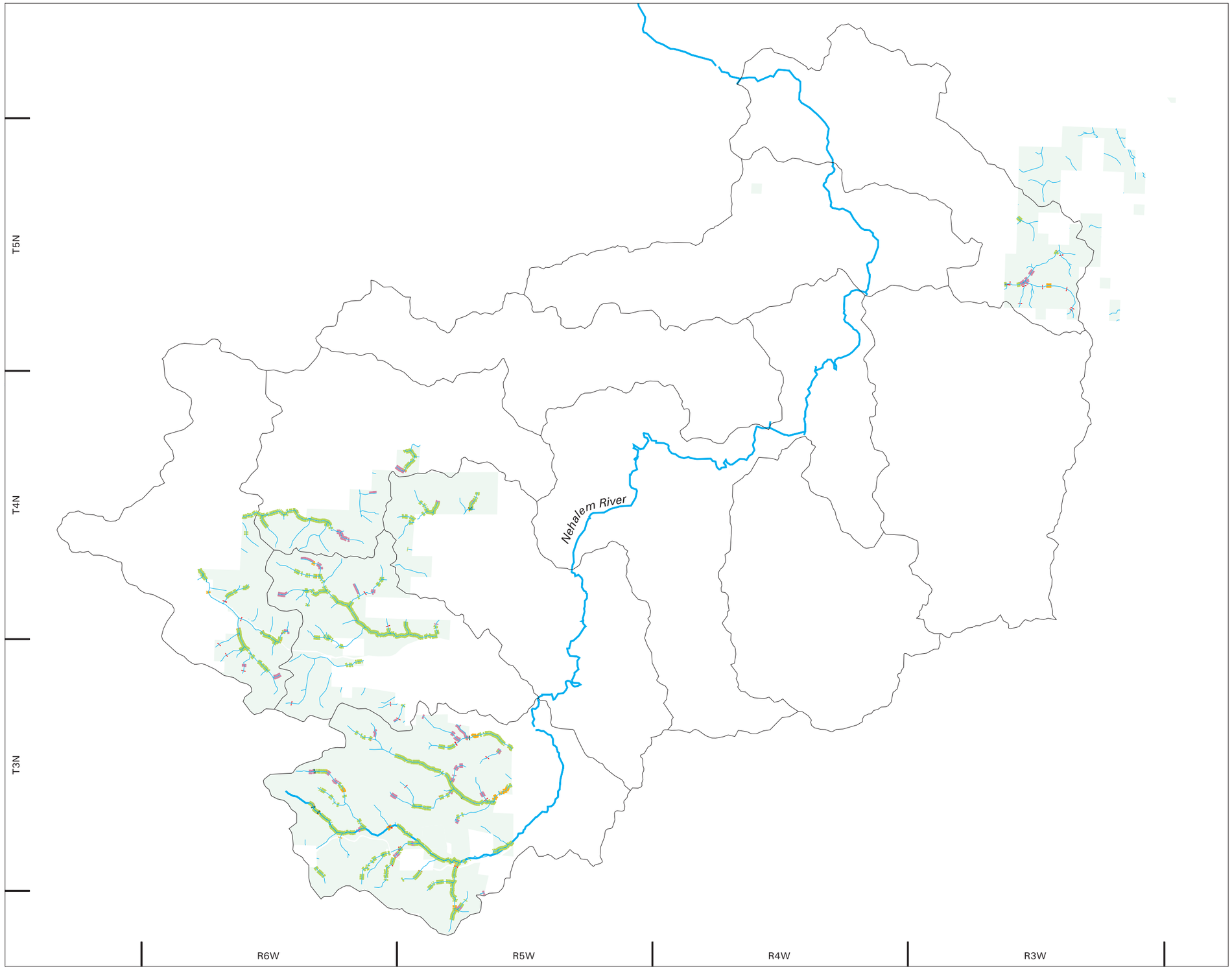
Upper Nehalem Watershed Analysis

Figure 12-2(a)

Scenarios for Enhancing Wood Recruitment Potential

Astoria District

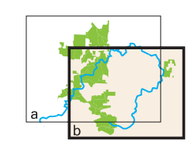


Legend

- 1 - Vegetation Composition
- 2 - Development
- 3a - Sparse Hardwood Species
- 3b - Sparse Conifer and Mixed Species
- 4 - Hardwood Senescence
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Numbers 1-4 indicate recommended alternative vegetation management scenarios.

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

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Upper Nehalem Watershed Analysis

Figure 12-2(b)

Scenarios for Enhancing Wood Recruitment Potential

Forest Grove District

The similar frequencies of the low recruitment potential categories at the 100-year compared to the 50-year time period was principally a result of the ongoing dynamic between stand growth and riparian losses due to hardwood senescence and channel disturbances developing sparse stand conditions.

Benda and Dunne (1997) predicted 16 percent of forests across the landscape the size of the upper Nehalem watershed would be less than 50 years old and 30 percent would be less than 100 years old. Disturbances occur episodically rather than at a constant rate, but over a long period of thousand's of years, the overall long-term average level of natural disturbance equates to 0.3 percent of the forest per year.

Disturbance regimes capable of altering the riparian vegetation character along the streambank zone include stand-replacing fires, wind-throw and major channel forming events like floods and debris flows. Assuming disturbances in the riparian zone are similar to the total landscape disturbance rate, one can anticipate 16 percent of the riparian forest along the streambank (RA1) zone would be modified in the first 50 years. This assumption is likely in the appropriate range since riparian zones experience more channel-related disturbances but less fire-related disturbances than upland forests.

A new hardwood stand requires approximately 50 years of growth to: (1) comply with the OWEB reference stand (HMD with medium-sized trees 12 to 24 in. in diameter) and (2) to provide a moderate potential rating for recruitment of large wood to channels (WFPB 1997). As such, a disturbed deciduous stand needs to be re-initiated prior to or exactly at year 50 to contribute to mature PFC in RA1 in a 100-year time frame. Depending upon when the channel disturbance occurred, it is possible some of the low recruitment potentials (perhaps upward to 15 percent) modeled in Chapter 6 could offer moderate recruitment capabilities within a 100-year time frame.

The watershed analyst team was less confident of the predicted wood recruitment results at 100 years than at 50 years. This confidence level was a result of: (1) multiple possible vegetation successional pathways from a given starting condition, (2) the assumption of no stand-replacing disturbance events and (3) the extended time frame.

12.1.2.3 Longer Than 100-Year Time Frame

Development of shade tolerant conifer species as a second cohort was anticipated to occur under many of the existing hardwood and grass/shrub stands (Assessment Table 6-3). Some of these

stands were predicted to provide moderate and high levels of wood recruitment in 150 to 200 years. Nevertheless, given stand replacement disturbance events and ongoing hardwood senescence, it is likely a mosaic of stand ages and wood sizes will prevail on the landscape. A component of the riparian zone will remain in either a young age class or in sparse densities offering low wood recruitment potentials. It was not possible to anticipate the dynamics involved with any degree of confidence to quantify the influence. Under natural disturbance regimes in the Nehalem Watershed (Benda and Dunne 1997), it was estimated approximately 16 percent of the entire area basin would have forests in age classes less than 50 years old with 30 percent less than 100 years old (Assessment Figure 3-1, based on the work of Benda and Dunne [1997a] for the Oregon Coast Range).

12.1.3 Alternative Vegetation Management to Achieve the PFC for Large Wood

Anticipated future management strategies including NW FMP and SAHs are not anticipated to hinder achievement of PFC for large wood in 100 years. However, the existing conditions within some riparian stands will have an ongoing influence on the ability to achieve PFC in the future. Recommendations for alternative vegetation management to achieve the wood recruitment potential for stands remaining low in 100 years vary by the specific group of situations in each stand. The followings current conditions were anticipated to inhibit development of PFC in a 100-year time frame under the proposed management scenarios (Figure 12-2a,b).

1. ***Vegetation Composition:*** Riparian zones dominated by bare ground, grasses, shrubs.
2. ***Riparian Structures/Development:*** Encroachment of road and rail line structures within the 100-ft riparian zone.
3. ***Sparse Levels of Stocking in Stands:*** Sparse hardwood, mixed species and conifer stands that hinder development of a second cohort.
4. ***Hardwood Senescence:*** Dense hardwood stands (HMD and HSD) that become sparse, yet hinder development of a second cohort.

Alternative management scenarios for each of the four groups of situations are discussed below.

12.1.3.1 Vegetation Composition (Bare Ground, Grasses, and Shrubs).

A total of 5.8 miles of riparian areas along fish-bearing waters (2.4% of ODF lands in both Management Districts) in the Upper Nehalem Watershed were within this category. Conditions within 100 years were not forecasted to provide sufficient wood diameters to qualify as large (> 24 in.) wood. A total of 0.4 miles in the riparian zones was comprised of bare ground. It was assumed bare ground implied the presence of surfaces, such as exposed hard rock, that would not support development of a riparian vegetation stand.

The recommended alternative forest management practice for locations where grasses and shrubs exist in riparian areas include:

1-1. For locations where site conditions are conducive for conifer tree establishment, perform active silvicultural management by means of vegetation removal, site preparation and replanting with appropriate conifer species. Verify the replanted stand becomes established within the first 15 years.

12.1.3.2 Riparian Structures

The frequency of roads or railroads in the riparian zone appeared to be low (Chapter 8). The RIMS database categorized approximately 15 miles of stream-adjacent roads (road prisms within 100 ft of a fish-bearing channel). This distance corresponds to 6 percent of the fish-bearing stream network in both Management Districts. However, only 0.4 scattered miles of the riparian polygons identified in the aerial photographic assessment indicated the dominating presence of either roads or rail lines. The discrepancy between the on-ground survey (RIMS database) and the aerial photographic assessment was likely due to the lack of road observation through the riparian canopy on the photos. Regardless, the level of road surface encroachment in the riparian zone was small with respect to the overall wood recruitment potential along ODF stream reaches.

The recommended alternative forest management practice for riparian locations with stream-adjacent roads includes:

2-1. Consider road relocation when and where feasible per the guidelines and prioritization established in Chapter 14 (Road Management).

12.1.3.3 Sparse Stands

Hardwood Species: Approximately 3.6 discontinuous stream miles adjacent to ODF lands (1.5%) in the upper Nehalem Watershed were identified in a current sparse hardwood condition. Vegetative growth and succession within 100 years were not forecasted to provide sufficient wood diameters to qualify as large (> 24 in.) wood.

The recommended alternative forest management practice for riparian locations supporting sparse hardwood stands include:

3-1. For locations where site conditions are conducive for conifer tree establishment, perform hardwood conversion by completely removing hardwoods between 25 and 100 ft from the stream bank, and actively planting with an appropriate conifer species for the site conditions. Verify the new stand becomes established within the first 15 years.

Conifer and Mixed Species: Depending upon the understory and site conditions and the initial stand density, some of the mixed and coniferous sparse stands were predicted to remain in a sparse condition, developing only a moderate level of wood recruitment potential within 100 years. A total of 10.5 stream miles (4.4%) of the fish-bearing channel network currently supported sparse stands of either coniferous or mixed species. The recommended alternative forest management practice for riparian locations supporting sparse, mixed or coniferous stands include:

3-2. Where sparse overstory conditions and soil conditions allow the establishment of a coniferous stand, underplant with appropriate coniferous species and verify an understory stand becomes developed within the first 15 years.

3-3. Consider removal of the hardwood component between 25 and 100 ft from the stream channel to allow an improved chance of conifer establishment and free-to-grow conditions.

12.1.3.4 Hardwood Senescence

Many of the dense hardwood stands were anticipated to become sparse due to mortality within the 100-year time frame. Development of a second stand cohort of any species in the understory was also assumed to be difficult without some form of stand manipulation or disturbance. Sparse conditions would not likely offer a sufficient level of wood recruitment within 100 years. A total

of 52.3 stream miles (22%) of the fish-bearing channel network currently supported dense hardwood stands that might be vulnerable to senescence.

Rather than early, pro-active stand manipulation, the alternative management recommendation for this riparian situation follows:

4-1. Assess the future level of site-specific riparian disturbances in the watershed.

a. If channel and riparian disturbances are creating a mixture of stand composition and age class conditions, especially in the inner (RA1) zone, then no management activity is needed.

b. If, however, a dense hardwood riparian stand matures to the point of imminent mortality, consider hardwood conversion per alternative vegetation management recommendation #3-1 above.

12.2 RIPARIAN SHADE/WATER TEMPERATURES

12.2.1 Sub-Watersheds that have Achieved PFC for water temperature

Many of the 6th field HUCs and Management Basins are currently predicted to offer riparian conditions characteristic of PFC for shade and surface water temperatures. These results are consistent with the water temperature measurements in ODF streams (Table 11-9).

More than 90 percent of the fish-bearing stream lengths on ODF lands are estimated to currently support PFC water temperatures based on the level of canopy closure and height of riparian vegetation in sub-watersheds located in Beneke, Buster, Fishhawk, Hamilton, Northrup, McGregor, Wheeler and Wilark Management Basins (Table 11-10). In general, the watershed assessment estimated the Forest Grove District has 96 percent (83 miles) and the Astoria District 90 percent (136 miles) of the fish-bearing streams in properly functioning shade conditions to maintain surface water temperatures (Chapter 9).

Sub-watersheds in the Crawford, Lousignot, Quartz, and Sager Management Basins and in scattered lands offered 80 percent or less of the fish-bearing stream miles in riparian conditions considered suitable for achieving PFC for water temperatures. Riparian conditions in these sub-watersheds were regarded as likely more open than conditions prior to European influence, especially in headwater regions of the subbasins. Many of these riparian zones were determined

to be on a trajectory to PFC and should achieve such conditions within a 50-year time frame as described below.

12.2.2 Sub-Watersheds with Suitable Conditions for the Development of PFC, for Water Temperature in 50, 100 and More Than 100 Years in the Future

Predictions of canopy closure and water temperatures based on riparian conditions 50, 100 and more years in the future were made by projecting existing stand conditions adjacent to fish-bearing channels on ODF lands in the watershed with vegetation succession projections. Effective vegetation heights predicted from the future stand characteristics were subsequently included in a VTS assessment of the radiation blocking elements along streams as a function of channel width and elevation to estimate surface water temperatures. Assumptions for forest management included stand characteristics resulting from the Salmon Anchor Habitat strategy (SAHs) along fish-bearing streams in the Buster, Fishhawk, Lousignot, and the Upper Rock Cr. HUCs [0-100 ft no-harvest zone] and the NW FMP strategies elsewhere on ODF lands in the watershed [0-25 ft no-harvest streambank zone; 25-100 ft Mature Forest Condition (MFC) inner zone]. The VTS temperature model incorporated an option of lowering the effective tree height to accommodate the concept of created openings in the riparian stand as a result of disturbance conditions. For proper context, the results were compared to reference conditions anticipated under natural disturbance regimes for western Oregon Coast range forests after Benda and Dunne (1997).

12.2.2.1 50-Year Time Frame

Ninety eight percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (234 miles) were anticipated to develop sufficient riparian stand characteristics to generate PFC for shade and water temperature in the next 50 years. All of the Management Basins were predicted to exceed 96 percent of the stream miles in conditions consistent with PFC, with the exception of Quartz. The Quartz Management Basin was anticipated to support 90 percent of the stream miles with a high probability of achieving PFC. This frequency is likely consistent with, or exceeds, historic riparian stand conditions under natural disturbance regimes.

Only 2.6 miles (1.1%) and 1.7 miles (0.7%) of the stream lengths adjacent to ODF lands in both Management Districts were predicted to have a moderate and high risk, respectively, of not achieving PFC in 50 years. The riparian situations generating some degree of risk to achieving

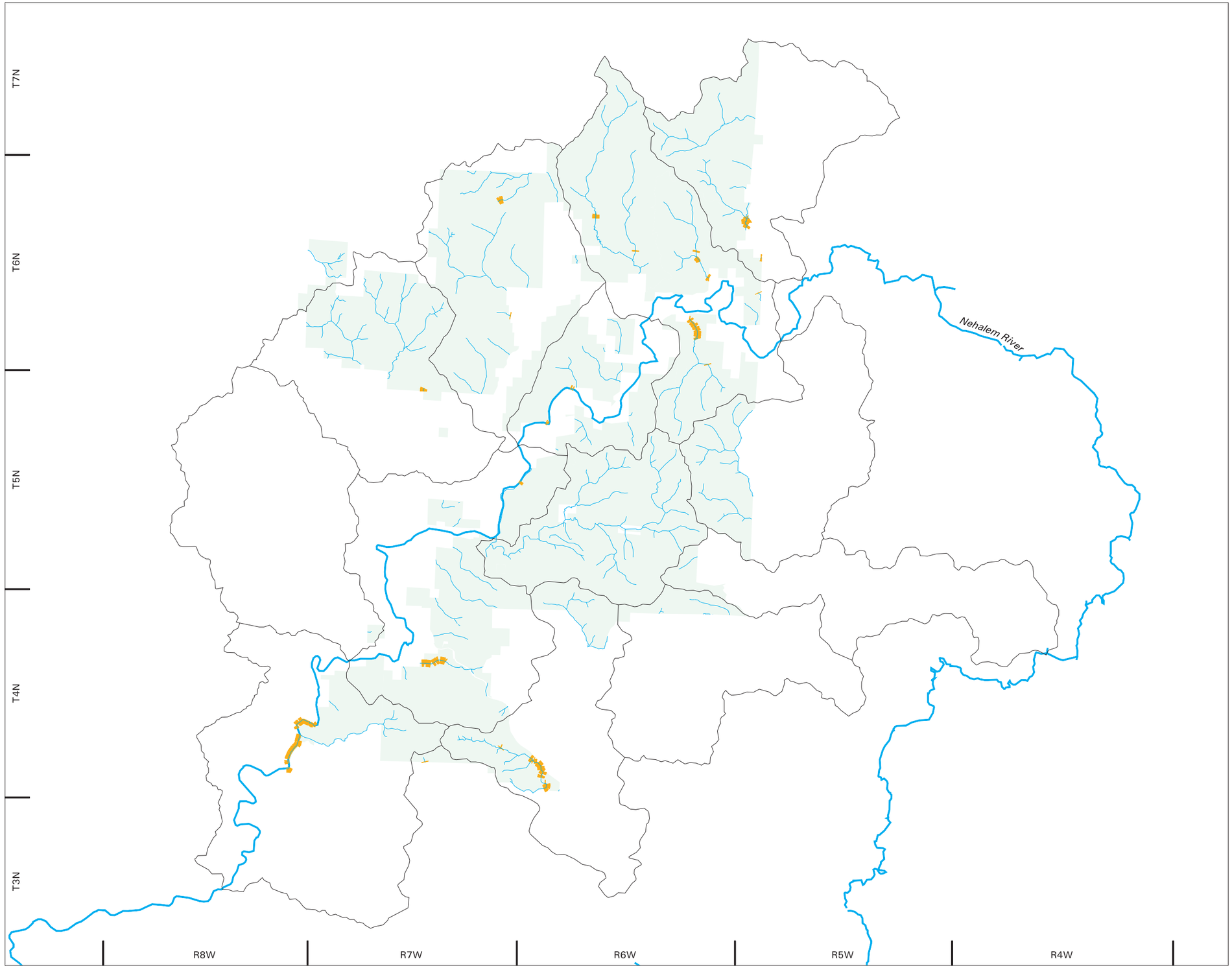
PFC were the primary result of understory vegetation conditions precluding the establishment of a second cohort and low densities of some hardwood stands.

12.2.2.2 100-Year Time Frame

Very little difference was predicted in the probability of achieving PFC related to shade and water temperature between the 50- and 100-year time frames. Nearly ninety seven (97%) percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (230 miles) were anticipated to retain sufficient riparian stand characteristics to generate PFC in 100 years. A minor amount (1%) of riparian canopy was anticipated to open sufficiently compared to 50-year time frame to potentially increase surface water temperatures as a result of hardwood senescence. Approximately 3.3 miles (1.4%) and 5.2 miles (2.2 percent) adjacent to ODF lands in both Management Districts were predicted to have a moderate and high risk, respectively, of not achieving PFC in 100 years (Figure 12-3a,b). The principal anticipated differences between the 50- and 100-year time frames were in both the Quartz and Lousignot Management Basins where abundant hardwood stands were anticipated to become sparse through senescence. As shown in Figure 11-4, the increase in the distribution of fish-bearing waters exceeding PFC changed from 1 to 3 percent between 50 and 100 years in the Astoria Forest District and remained unchanged in the Forest Grove District. The degree of channel openness predicted in both Districts remained consistent with historic riparian stand conditions under natural disturbance regimes.

12.2.2.3 Longer Than 100-Year Time Frame

Development of shade tolerant conifer species as a second cohort was anticipated to occur under many of the existing hardwood and grass/shrub stands (Appendix F). Some of these stands were predicted to provide high levels of shade in 150 to 200 years. Nevertheless, with stand replacement disturbance events and ongoing hardwood senescence, it was likely a mosaic of stand ages and shade levels would prevail on the landscape. A component of the riparian zone would remain in either a young age class or in sparse densities offering low radiation-blocking potentials compared to the channel sizes. It was not possible to anticipate the dynamics involved with any degree of confidence to quantify the influence. Under natural disturbance regimes in the Nehalem Watershed (Benda and Dunne 1997), it was estimated approximately 16 percent of the entire area basin would have forests in age classes less than 50 years old (Assessment Figure 3-1, based on the work of Benda and Dunne (1997) for the Oregon Coast Range).

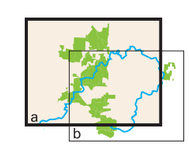


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

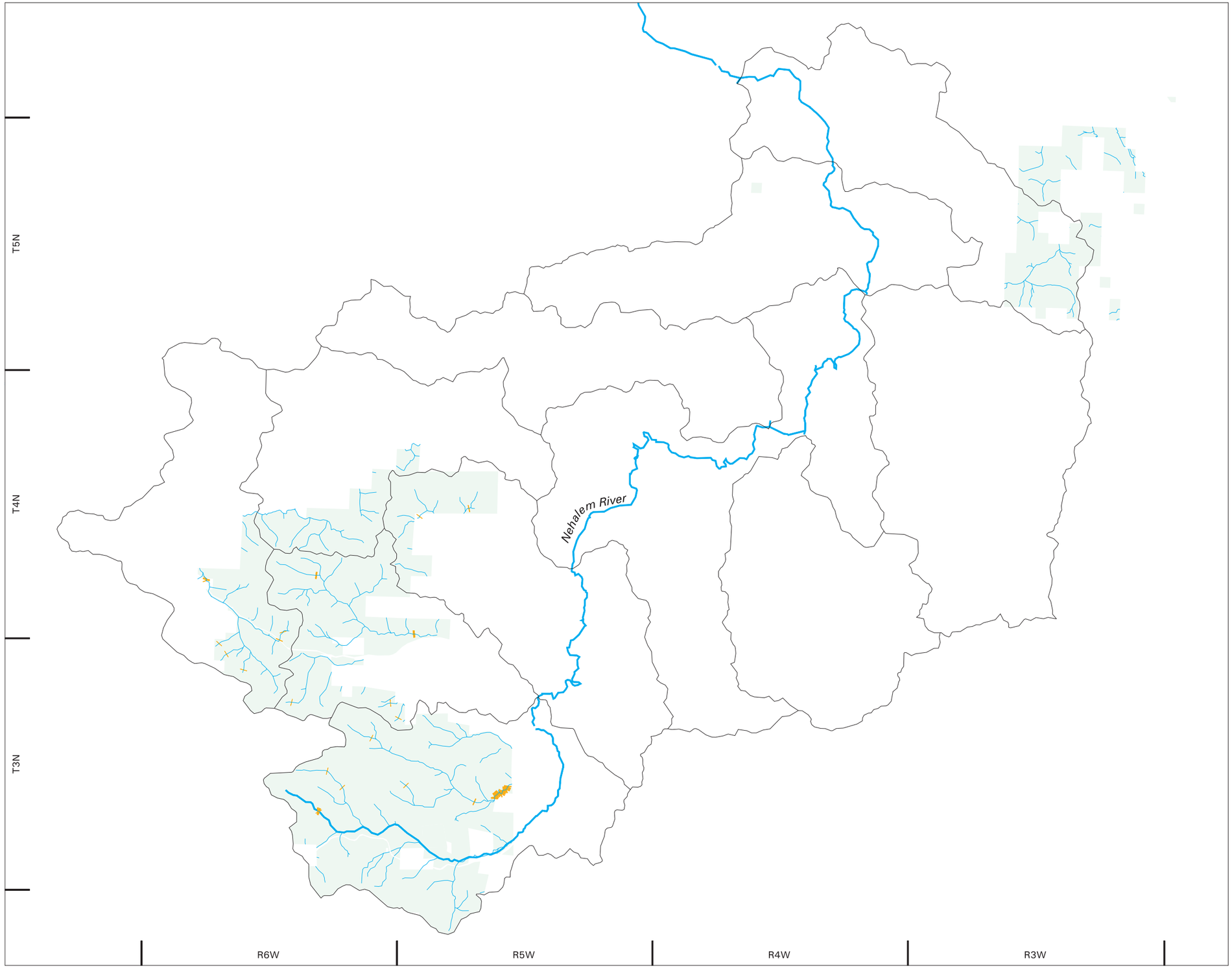
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-3(a)

Predicted Risk to Achieving PFC for Water Temp. in 100 Years

Astoria District

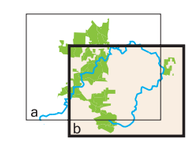


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-3(b)

Predicted Risk to Achieving PFC for Water Temp. in 100 Years

Forest Grove District

12.2.3 Alternative Vegetation Management to Achieve the PFC

PFC for water temperature not only varies by the amount of canopy coverage based on natural growing conditions for riparian stands and natural disturbances, but by channel size and location in the watershed (elevation and distance from the watershed divide). PFC for water temperatures was determined for each of the ODF Management Basins in the watershed in Assessment Chapter 9 based on an evaluation of reasonably achievable water temperatures. PFC ranged between 11.6 and 17.8^{o}C for various channel sizes, elevations, and distance from divide across the twelve management basins (Table 11-9). The distribution of reasonably achievable reference temperatures integrating the frequency of channel sizes, elevations and natural disturbances for discrete thermal classes on fish-bearing streams on all ODF lands in the watershed was as follows.

Thermal Class	Predicted Historic Frequency
< 12°C	1%
< 16°C	96%
< 18°C	3%
> 18°C	0%

The reference temperature distributions differed slightly between the two Management Districts since the Astoria District encompasses lower elevation lands than the Forest Grove district. The reference, current, and projected 50- and 100-year temperature distributions are summarized in Table 12-4. Most (90%) of the fish-bearing streams were currently consistent with reference water temperatures in each basin. Nearly all of the fish-bearing waters (98% and 97%) were anticipated to be consistent with reference temperatures at the 50-year and 100-year time frames, respectively. Only, 2.8 stream miles (1.2%) of the total ODF lands in the watershed were not anticipated to achieve PFC in 100 years. Most of the stream miles anticipated to exceed PFC were located in Quartz, Wheeler, Northrup, and the Beneke Management Basins (see Figure 12-3a,b).

Achieving PFC in the riparian zone was more difficult for generating the large wood recruitment potential in the Upper Nehalem Watershed than it was for generating proper conditions to maintain surface water temperatures. Recommendations for alternative vegetation management to address specific low wood recruitment potential issues will provide a corollary benefit to surface water temperatures. Based on the watershed assessment, there are no additional recommendations for alternative management scenarios for achieving properly functioning shade conditions.

Table 12-4. Distribution of forecasted water temperatures on fish-bearing streams on ODF lands in the upper Nehalem Watershed

	Surface Water Temperature Class				**Probability of Exceeding PFC**		
	<12°C	12 – 16°C	16 – 18°C	>18°C	Low	Moderate	High
ODF Lands							
Reference	1%	96%	3%	0%	100%	-	-
Current	0%	86%	6%	9%	92%	7%	1%
50-Yr	2%	95%	3%	0%	98%	1%	1%
100-Yr	2%	94%	3%	1%	98%	2%	1%
Forest Grove District							
Reference	3%	97%	0%	0%	100%	-	-
Current	0%	92%	7%	1%	96%	4%	0%
50-Yr	4%	95%	0%	1%	99%	1%	0%
100-Yr	5%	94%	0%	1%	99%	1%	0%
Astoria District							
Reference	0%	95%	5%	0%	100%	-	-
Current	0%	82%	5%	13%	90%	9%	1%
50-Yr	0%	95%	5%	0%	98%	1%	1%
100-Yr	0%	94%	5%	1%	97%	2%	1%

13. KEY ANALYSIS QUESTIONS FOR SLOPE STABILITY

The following questions were addressed to help identify areas in the watershed where landslides may occur and may impact stream habitat.

1. *Are there landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts? If so, identify the specific hillslopes and stream reaches, describe why they pose a high risk to streams, and describe how management will affect possible stream sediment or scour impacts?*
2. *Which of the mechanisms (shallow landslides, deep-seated landslides, and soil creep) provide a substantial source of sediment to streams?*
3. *Which steep slopes will likely provide future in-stream key pieces of large wood to debris flow prone channels?*

13.1 LANDSLIDE-PRONE HILLSLOPES THAT POSE A HIGH RISK OF DOWNSTREAM SEDIMENT OR SCOUR IMPACTS

Landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts can be identified based on the slope gradient, landslide density, and debris flow probability maps provided in this section for each of ODF's management areas (see Table 7-1 and Appendix D, Figures D-9 to D-59). The specific stream reaches likely to be impacted can also be identified using the debris flow probability maps (both scour along the predicted paths and deposition at the downstream end of the predicted path). However, additional site-specific information is required to evaluate the risk posed by debris flows to fish-bearing channels (see below). Evaluating how forest management will affect debris flow risk and ultimately the conditions of channels will require information on rates and spatial patterns of timber harvest, information only available from ODF planning staff. Understanding how channel conditions can be affected by debris flows can be enhanced by referring to the discussion of disturbance in the Nehalem watershed analysis.

13.1.1 Additional Information Needs

Critical information is needed on why landslide-prone hillslopes (or debris flows) pose a high risk to streams and how management will affect stream sediment or scour impacts. As mentioned in Section 3.2, the ecological effects of landslides and debris flows is a complex issue. Detailed analysis of channel conditions could be used to understand whether landslides and debris flows pose a high risk to streams and hence how forest management can affect that risk at

any particular location. Hence, an additional information need includes detailed field surveys in landslide and debris flow deposition zones to estimate how mass wasting would alter channel and valley floor morphology. In the absence of detailed field measurements, however, it can be assumed that landslides and debris flows pose a high risk. The assumption of high risk could lead to certain types of ODF forest management policy decisions, such as no or limited road building or harvest prescriptions. Such prescriptions may be overly conservative. Therefore, it may be important to create additional environmental context from which to understand effects of debris flows using both models or field data on channel conditions, or a combination of both.

Field information could be used to determine whether landslides and debris flows are "properly functioning." "Properly functioning" refers to the behavior of mass wasting that contributes to habitat formation through the introduction of sediment and large wood that ultimately creates aquatic habitats. Properly functioning could be defined in terms of composition (i.e., in their respective proportions of wood and sediment in landslide and debris flow deposits) and whether landslides and debris flows in managed forests are occurring at rates in space and time in the same order of magnitude as in natural systems. Riparian buffer strips along debris flow-prone headwater streams could be used as a strategy to ensure future mass wasting wood is transported to low-gradient, fish-bearing streams (i.e., maintaining a natural level of debris flows as a wood recruitment agent). Other types of analyses could be used to investigate the spatial and temporal patterns of mass wasting in managed versus unmanaged systems.

13.2 SEDIMENT SOURCE ANALYSIS

The Oregon Department of Forestry requested an evaluation of the relative importance of sediment sources in the Nehalem watershed (i.e., question #2 above). This information would be useful in understanding if and how forest management might be contributing to increased sedimentation in streams. For example, if landslides and debris flows are major sources of sediment, and timber harvest is linked to increased landslide and debris flow rates, then forest management may lead to increased rates of sediment to stream channels. However, the ecological ramifications of landslides and debris flows is more complex than simply constructing sediment budgets; see the discussion of natural disturbance in the Nehalem Watershed Analysis. A thorough understanding of sedimentation mechanisms in the upper Nehalem Watershed would require the construction of a sediment budget or at least a partial budget focused on the principle erosion processes, specifically mass wasting and soil creep. Development of a quantitative sediment budget would require an aerial photograph and field-based assessment of the various forms of erosion in the Nehalem watershed, including shallow landslides in bedrock hollows, shallow landslides in inner gorges, debris flows in first- and second-order streams, soil creep

along channels of all orders but in particular headwater streams, and soil creep or shallow landsliding from deep-seated landslides. Historical aerial photography can be used to develop a time series of certain types of erosion (visible from air photos) such as debris flows. Refer to Dietrich and Dunne (1978) and Reid and Dunne (1996) for more complete discussions on creating sediment budgets. Erosion from logging roads was not evaluated in this analysis since the sediment source budget outlined below is primarily qualitative. A separate roads analysis is contained in Chapter 14.

13.2.1 Qualitative Comparative Analysis

It was feasible to infer the relative importance of the four different soil erosion mechanisms from information available in the Nehalem watershed as well as from other studies in the Oregon Coast Range. In the discussion that follows, sediment supply was considered for large, high-order channels (third- and higher-order channels) since the focus of the analysis was on the supply, storage, and routing of sediment and wood in fish-bearing streams. In the relatively steep terrain of the North Coast Range central Oregon Coast Range, sediment budgets have indicated the overwhelming importance of shallow landslides and debris flows in supplying sediment to the higher-order channel network (Dietrich and Dunne 1978; Reneau and Dietrich 1991; Benda and Dunne 1997). The dominance of shallow landslides and debris flows in the sediment budget would occur discontinuously in the Nehalem watershed because of the spatial variation in the predicted landslide and debris flow potential (e.g., Figure D-61). Shallow landslides and debris flows may dominate the sediment sources primarily in the western portion of the study area and locally in other areas predicted to have relatively high landslide and debris flow potential.

The ODF mapping of large, deep-seated landslides (Figure D-62, Appendix D) suggests this form of mass failure is a relatively insignificant contributor to sediment supply in the study area. Moreover, because of the low temporal frequency of such large and deep failures, the majority is presumed to be old and hence, should not represent a significant contribution to the sediment budget. Undoubtedly, small deep-seated failures exist in the Nehalem watershed that were not mapped because of dense forest cover. It is possible deep-seated slides, including small ones that border many headwater streams, may locally be a significant component of the sediment budget. If improved methods of mapping reveal additional deep seated failures, such large slides may become a significant source of sediment. However, the relative importance of deep-seated failures likely depends on the subbasin of interest. For example, the landslide and debris flow models that were run in the Nehalem watershed show a pronounced gradient characterized by a high potential of debris flows in the southwestern section of the study area with declining

potential towards the northeast (see Figure 59 in the Slope Stability Assessment Sections). Consequently, the relative importance of deep-seated failures may follow this gradient, but in reverse. The highest relative importance of deep-seated slides may occur in the northeast with declining potential towards the southwest.

Soil creep, a process that can comprise rheological soil creep, animal burrowing, and tree throw, has been estimated to vary from approximately 1 mm/yr to 1 cm/yr in various parts of the central Oregon Coast Range (Dietrich and Dunne 1978, Reneau and Dietrich 1991, Benda and Dunne 1997). Although these values come from steep hollow topography, the values provide a rough order of magnitude bracket for soil creek. The values do not apply to toes of deep-seated slides which may have higher rates of soil creep. Even with such soil creep rates, sediment budgets in the central Oregon Coast Range concluded shallow failures and debris flows dominate the erosion regime (in steep, mass wasting prone landscapes). One reason for this finding is sediment introduced by soil creep into first- and second-order channels (comprising 70% to 80% of the entire network) is subsequently removed by debris flow and hence becomes part of the debris flow component of the sediment budget. Thus, the sediment source analysis concentrates on large, fish-bearing channels (i.e., third- and higher-order channels) since the focus is on impacts to high quality aquatic habitats. In areas where small headwater streams are not prone to debris flows (in significant areas of the Nehalem study area, see Appendix D, Figures D-8 to D-59), soil creep may become significantly more important and approach 10 percent or more of the total sediment supply to large channels.

Shallow failures in inner gorges may also be a dominant component of the sediment budget in some areas of the Nehalem where steep slopes abut channels, particularly along headwater streams that comprise approximately 70-80% of the cumulative channel length. In addition to post-fire accelerated landsliding in the Oregon Coast Range (Benda and Dunne 1997), increased surface erosion following fire may account for at least 50% of the long-term sediment yield (Roering and Gerber 2005). The process of wildfire erosion was not investigated during the Nehalem watershed analysis since it would require sophisticated computer simulation modeling and recent fires were limited to Quartz and McGregor management areas.

In summary, in certain portions of the study area, such as along the western margin, shallow landslides and debris flows likely dominate the supply of sediment to large fish-bearing streams and rivers. Inner gorge slides are also likely important in certain areas. Soil creep is probably minimal. In other, less highly dissected and lower gradient portions of the Nehalem Project Area (northern and eastern portions), the role of shallow slides and debris flows is probably diminished (< 50%) with soil creep becoming more important. Over the entire area, post fire

erosion is probably significant and may dominate the erosion regime in the form of landslides, debris flows, inner gorge failures, surface erosion, and gullying over the long term (i.e., centuries). All of the erosion processes mentioned contain both coarse and fine sediments. Analysis of colluvium in the central Oregon Coast Range indicates that fine sediment (sand size and less) can comprise up to 30 to 40% (by weight) of samples (Benda and Dunne 1997). Moreover, the attrition of gravel during fluvial transport will also generate large volumes of fine sediments.

13.2.2 Additional Information Needs

The sediment budget for the Nehalem watershed, and hence the comparative analysis of different sediment sources, can only be inferred from terrain information (i.e., slope, landslide, and debris flow predictions) and from other erosion studies conduced in the Oregon Coast Range. To obtain a more quantitative and accurate estimate of the various rates of erosion in the Nehalem watershed would require additional aerial photograph interpretation and field surveys. For example, historical aerial photograph analysis could be used to estimate landslide and debris flow rates (#/time/area). Field surveys could estimate the average volume of sediment associated with landslides and debris flows. Field surveys should also be used to document the spatial frequency and size of streamside landslides. Surveys of channels could be used to measure bank erosion over some elapsed time period. To obtain estimates of the erosion regime in the Nehalem watershed over a large temporal scale (centuries), computer simulation models could be used to estimate landslides and debris flows associated with periodic fires and large storms.

13.3 STEEP SLOPES LIKELY TO PROVIDE FUTURE IN-STREAM KEY PIECES OF LARGE WOOD TO DEBRIS FLOW PRONE CHANNELS

An empirically-calibrated debris flow model was used to investigate which hillslopes would likely provide future in-stream large wood to debris flow prone channels; see Appendix D, Figures D-8 to D–59 for each of the 13 management basins, organized by HUC 6th-field watersheds. The mapped debris flow corridors are those predicted to deliver to fish-bearing streams, defined as channels less than 12%. The debris flow model, including the prediction of wood delivery to fish-bearing channels, is explained in detail in the Assessment Section and in associated Appendix D (that describes the model in greater detail). The 12% cutoff is based empirically on the comprehensive landslide and debris flow inventory in the central Oregon Coast Range (Robison et al. 1995). In general, most of the Nehalem watershed has a limited ability to deliver wood to fish-bearing channels by debris flow because of the overall low potential for shallow failures and debris flows. The highest potential for wood delivery from debris flows exists in the southwest corner of the study area.

14. ROAD MANAGEMENT

The following questions were addressed to help identify road related factors that may limit PFC's in the Upper Nehalem Project Area:

1. *Which roads need review by ODF for repair and why? What are the specific locations of the road issues?*
2. *What road segments should be considered by ODF for vacation or relocation and why?*
3. *Which stream crossings identified in the assessment phase, including fish passage barriers and crossings in poor condition, should be considered for replacement?*

14.1 ROAD CONDITION

Road condition in the Upper Nehalem Project Area was in overall good condition, with few isolated problems. Road drainage, prism condition, and critical location of roads in the project area were all assessed to be in good condition based on the 2005 RIMS surveys. Approximately 98% of road drainage was functioning properly or has only minor impairment, while 97% of road prisms were in proper condition or had only minor surface erosion (Chapter 8). In addition, the vast majority of roads (94%) were identified to be in non-critical location, with no inherent resource risk (Chapter 8). A limited number of isolated road sections identified to be in need of repair are described below.

Based on surveys of stream sediment composition by Kavanagh et al. (2005), overall levels of fine sediment in the project area rate fair to good in comparison to unmanaged reference reaches (see Section11.2). However, several streams within the project area were identified to have high fine sediment levels in need of improvement. These stream reaches with sediment concern are described in Section 11.2. The high levels of fine sediment in stream reaches in the project area are likely due in part to the influence of underlying sedimentary material in the study area (see Section 2.12). Given the level of fine sediments present naturally in stream channels, it is assumed additional inputs from roads should be avoided.

The level of sediment delivery to the stream from roads in the project area was presumed to be relatively low based on the present condition of forest roads (see Chapter 8). Based on road surveys conducted in 2005 (RIMS), the percentage of road length that is stream adjacent (9%)

and hydrologically connected to the stream network (16%) in the project area was low. In addition, minimal road length (0.26 mile) was identified to be in sidecast/fill and fill slide condition during the 2005 road surveys.

Road segments in the project area in need of repair and vacation or relocation were identified based primarily on road drainage condition, road prism condition, hydrologic connectivity of the road drainage to the stream network, critical road location and proximity to streams with sediment level concerns. Roads were secondarily sorted based on the location of the segment within Salmon Anchor Habitat (SAH). Based on the SAH strategy, roads in SAH were high priority for repair and improvement to minimize potential sediment delivery to streams. Salmon Anchor Habitat within the project area includes HUC's #171002020205 (Fishhawk Creek), #171002020304 (Buster Creek), and #171002020101 (Lousignont Creek).

14.1.1 Road Repair

A total of 85 road segments in the project area were identified and prioritized for on-site review for possible repair projects (Table 14-1). Road segments in need of repair were prioritized into three categories based on the following criteria:

1a – Road segments with prism Attention Priority (AP) code 1, sidecast/fill or fill slides, or stream in ditch critical location and hydrologic connectivity to the stream network.

1b – Roads with drainage AP code 1 and hydrologic connectivity.

1c – Road segments with prism AP code 2 and hydrologic connectivity.

1d – Roads with drainage AP code 2 and hydrologic connectivity.

2a – Roads with prism AP code 3 and hydrologic connectivity.

2b – Roads greater than 0.25 mile in length with hydrologic connectivity, and proximal to streams with sediment concerns.

2c – Roads greater than 0.50 mile in length with hydrologic connectivity.

3a – Roads with prism AP code 1, sidecast/fill or fill slides, or stream in ditch critical location and hydrologically disconnected.

3b – Roads with drainage AP code 1 and hydrologically disconnected.

3c – Roads with prism AP code 2 and hydrologically disconnected.

3d – Roads with drainage AP code 2 and hydrologically disconnected.

No roads with prism AP code 1 were identified in the project area.

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Lousignot	Vesper Spur 16850[5]	0.08	0.02	-	2	FS	Y	Y	N
Beneke	Beneke Vacated 1	0.45	0.03	-	-	FS	Y	N	N
McGregor	Lower Rock Creek	0.54	0.11	-	3	CT	Y	N	N
McGregor	Olson	1.49	0.03	-	-	SD	Y	N	N
Wheeler	South Lousignont	2.32	0.25	1	-	-	Y	Y	Y
Wilark	Little Clatskanie[5]	0.38	0.01	1	-	-	Y	N	N
Wheeler	Shields Spur 1.57 Mile	0.93	0.31	2	3	-	Y	Y	N
Quartz	Sterling Ranch 1005	0	0.17	2	-	-	Y	Y	N
Buster	Osweg 2010	0	0.08	2	-	-	Y	N	N
Wheeler	Shields Spur 1.57 Mile	1.40	0.31	-	3	-	Y	Y	N
Wheeler	BC 1.95	1.22	0.22	-	3	-	Y	Y	N
Wheeler	Shields Spur 1.72 Mile	0.48	0.20	-	3	-	Y	Y	N
Wheeler	Shields Spur 1.72 Mile	0.25	0.10	-	3	-	Y	Y	N
Quartz	Sterling Ranch 9010	0	0.07	-	3	-	Y	Y	N
Hamilton	Tidewater Loop 120	0	0.86	-	3	SP	Y	N	N
Beneke	Tidewater Loop 20	0.71	0.19	-	3	SP	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Osweg 20	0.03	0.12	-	3	-	Y	N	Y
Hamilton	Ebsen 10	0.86	0.09	-	3	SP	Y	N	N
Hamilton	Fishhawk Creek 05	0	0.09	-	3	-	Y	N	N
Hamilton	Tidewater Loop 135	0.63	0.09	-	3	-	Y	N	N
Hamilton	Tidewater Loop 135	0.96	0.06	-	3	SP	Y	N	N
Northrup	Northrup Creek 20	0.35	0.05	-	3	-	Y	N	N
Hamilton	Tidewater Loop	0.36	0.54	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.96	0.22	-	3	-	Y	N	N
Hamilton	Fishhawk Creek 1020	0	0.13	-	3	-	Y	N	N
Northrup	Foster 300	0.13	0.13	-	3	-	Y	N	N
McGregro	No Fo	2.89	0.12	-	3	SF	Y	N	N
Sager	Jones 10	0.59	0.10	-	3	-	Y	N	N
Quartz	Lost Lake	3.33	0.10	-	3	-	Y	N	N
Hamilton	Tidewater Loop 110[5]	0.85	0.09	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.81	0.08	-	3	-	Y	N	N
Quartz	Lost Lake	4.47	0.06	-	3	-	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Green Mountain	5.11	0.06	-	3	-	Y	N	N
Quartz	August Fire	3.02	0.06	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.64	0.05	-	3	-	Y	N	N
Hamilton	Tidewater Loop	0.98	0.05	-	3	-	Y	N	N
Beneke	Foster 16010	0.40	0.04	-	3	-	Y	N	N
Quartz	Sterling Ridge 60	0.53	0.04	-	3	-	Y	N	N
McGregor	Music	1.69	0.03	-	3	SF	Y	N	N
Buster	Osweg 3010	0.04	0.03	-	3	SF	Y	N	N
Wheeler	Clarkson Cr Spur 0.44 mi.	0.21	0.73	-	-	SP	Y	Y	Y
Fishhawk	Fishhawk Loop	3.33	0.69	-	-	-	Y	Y	Y
Wheeler	Section 10	0	0.52	-	-	SP	Y	Y	Y
Wheeler	Marshall	0.03	0.51	-	-	SP	Y	Y	Y
Wheeler	Clarkson Creek	0	0.45	-	-	SP	Y	Y	N
Wheeler	Clarkson Creek	1.02	0.41	-	-	-	Y	Y	Y
Beneke	Wild Goose Ridge 20[5]	1.81	0.31	-	-	-	Y	Y	N
Wheeler	Voltaire	0	0.30	-	-	-	Y	Y	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Wheeler	Derby Ridge	0.96	0.28	-	-	SP	Y	Y	N
Buster	Nettle Creek 30	0	0.26	-	-	-	Y	Y	N
Buster	Buster Creek	6.13	0.50	-	-	-	Y	N	N
Hamilton	Ebsen 1010	0	0.46	-	-	-	Y	N	N
Northrup	Northrup Creek	1.78	0.45	-	-	-	Y	N	N
Buster	Buster Creek	5.50	0.41	-	-	SP	Y	N	N
Sager	Deep Creek Relocated	0.98	0.40	-	-	SP	Y	N	N
Beneke	Beneke Vacated 1[5]	0.14	0.39	-	-	SF	Y	N	N
Buster	Grasslands 20	0.21	0.34	-	-	-	Y	N	N
Northrup	Northrup Creek	0.77	0.34	-	-	-	Y	N	N
Hamilton	Ebsen 10	0.37	0.33	-	-	SP	Y	N	N
Sager	Sager Creek	0.38	0.28	-	-	SP	Y	N	Y
Buster	Soak Alley	0.38	0.25	-	-	-	Y	N	N
Northrup	Northrup Creek	0.44	0.24	-	-	SP	Y	N	N
Buster	Buster Creek	6.70	0.24	-	-	-	Y	N	Y
Beneke	Beneke Vacated 1	0.56	0.23	-	-	SP	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Wage[5]	2.64	0.17	-	-	SP	Y	N	N
Buster	Stanley Creek	0	0.12	-	-	-	Y	N	Y
Buster	Buster Creek	1.71	0.88	-	-	SP	Y	Y	N
Hamilton	Tidewater Loop 80[5]	0	0.55	-	-	SP	Y	N	N
Hamilton	Tidewater Loop	2.10	0.83	-	-	SP	Y	N	N
Wheeler	SB 0.13	0	1.05	-	-	-	N	N	N
Wheeler	Ingersol Spur 1.64 mile	0	0.08	-	2	-	N	Y	N
Sager	East Sager Vacated 3	0.23	0.10	-	-	FS	N	N	Y
Crawford	Crawford Ridge 14010[5]	1.21	0.02	-	-	CT	N	N	N
McGregor	Music[5]	1.91	0.05	-	2	SP, SF	N	N	N
McGregor	McGregor	6.15	0.02	-	-	-	N	N	N
Quartz	Lost Lake 12020	0	0.03	-	-	-	N	N	N
Sager	Walker Ridge 40	0	0.15	2	-	-	N	Y	N
Wheeler	Morgan Cr. Spur 0.67 mi.	0.38	0.09	2	-	-	N	Y	N
Quartz	Lost Lake 180	0.05	0.21	2	3	SF	N	N	N
Buster	Walker Ridge 10	0	0.13	2	-	-	N	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Northrup	Foster 50	0.04	0.22	2	-	-	N	N	N
Northrup	Bovine 160	0.10	0.26	2	-	-	N	N	N
Quartz	Lost Lake 140	0.27	0.03	2	-	-	N	N	N
Quartz	Lost Lake 110	0.05	0.06	2	-	-	N	N	N
Quartz	Lost Lake 10	0	0.27	2	-	-	N	N	N

1 Only Drainage AP codes 1 and 2 are considered in this prioritization; AP codes 3-5 are not identified.

AP Code 1 indicates surface water is causing severe erosion of road prism and needs immediate attention.

AP Code 2 indicates surface water is causing moderate erosion of road or onto steep fill

2 Only Prism AP codes 1-3 are considered in this prioritization; AP codes 4 and 5 are not identified.

AP Code 1 does not exist in the project area.

AP Code 2 indicates arcuate cracks or other landslide is present reducing road width and drop on outside edge of road.

AP Code 3 indicates serious surface erosion or minor cutback slump.

3 Critical road locations identified include sidecast/fill slides (CT), fill slides (FS), stream in ditch (SD), stream parallel (SP), and steep fill (SF).

4 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.)

5 Road segment also contains culvert in need of replacement or repair.

Traffic intensity on forest roads within the project area was not considered in the road repair analysis. Traffic intensity can potentially have a significant impact on road condition and subsequent fine sediment delivery to streams. However, it can be difficult to quantify, as the level of travel on individual road segments fluctuates greatly due to forest harvest and management practices. Monitoring of traffic levels on roads segments identified as higher priority for repair may be warranted in order to prevent sediment delivery to streams.

14.1.2 Road Vacation

In order to identify roads in need of vacation or relocation, roads were analyzed using the same set of criteria described in Section 1.4.1.1. Road segments with multiple poor condition factors were considered for vacation and relocation. No road segments in need of vacation or relocation were observed in the Upper Nehalem Project Area.

14.2 STREAM CROSSING CONDITION

Maintaining proper stream crossing condition is critical to maintaining fish passage and preserving road fill condition at the crossing site. Based on 2005 RIMS surveys, present condition of stream crossings on the Upper Nehalem Project Area was good (see Chapter 8). A total of 720 stream crossings exist in the Upper Nehalem Project Area, of which only three were identified to be barriers on known fish bearing streams (Table 8-9). No washouts of stream crossings were identified during the 2005 surveys, however eight sites were determined to be at high risk of washout (Table 8-10).

Stream crossings were prioritized for replacement and repair based on fish passage restrictions in known fish bearing streams, crossing AP code, and washout hazard rating. Crossings were secondarily sorted based on location of the crossing within SAH and proximity of the crossing to streams with sediment concern.

Crossings with fish passage restrictions on streams with likely fish presence were identified so that fish presence surveys can be conducted to verify fish presence. Streams with likely fish presence include streams with habitat suitable for fish presence, but for which no fish presence survey has been conducted.

14.2.1 Stream Crossing Replacement

A total of five stream crossings were identified for consideration of replacement within the project area (Table 14-2). While it is likely most of the crossings identified will require

replacement, it is recommended that further field assessment of these crossings is conducted, as it is possible that a portion may only require retrofitting. Stream crossings to be considered for replacement were prioritized based on the following criteria:

1 – Crossings that restrict adult fish passage on known fish bearing streams.

2 – Crossings with AP Code 1 and high washout risk.

3 – Crossings with AP Code 2 and high washout risk.

No adult fish passage barriers on known fish bearing streams exist in the project area.

Table 14-2. Streams crossings in the Upper Nehalem project area prioritized for replacement based on crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Crossing Location (Road Mile)	AP Code[1]	Washout Hazard Rating	SAH[2]	Sediment Concern
Buster	Grasslands	4.50	1	H	Y	N
Wilark	Little Clatskanie	0.38	1	H	N	N
Buster	Osweg 10	0.28	2	H	N	N
Sager	Grand Rapids 601030	0.19	2	H	N	N
Hamilton	Tidewater Loop	3.49	2	H	N	N

1 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.
AP code 1 indicates the crossing is in failure
AP code 2 indicates the crossing is nearing failure.

2 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

14.2.2 Stream Crossing Repair

A total of 27 stream crossings were prioritized for repair in the project area, and will likely require retrofitting in order to function properly (Table 14-3). Prioritization of stream crossing repair was based on the following criteria:

1 – Crossings that restrict juvenile fish passage on known fish bearing streams.

2 – Crossings with high washout risk.

3 – Crossings with AP code 1 and moderate washout risk.

4 – Crossings with AP code 2 and moderate washout risk.

5 – Crossings with AP code 1 and low washout risk.

6 – Crossings with AP code 2 and low washout risk.

Table 14-3. Streams crossings in the Upper Nehalem project area prioritized for repair based on fish passage condition, crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

			Fish Passage					
Management Basin	**Road Name**	**Crossing Location (Road Mile)**	**Known Juvenile Barrier**	**Stream Length Upstream of Barrier (Mi)[1]**	**AP Code[2]**	**Washout Hazard Rating**	**SAH[3]**	**Sediment Concern**
Wilark	Oak Ranch	0.12	Y	14.41	-	L	N	N
Wheeler	North Lousignont	4.41	Y	3.7	-	L	Y	Y
Buster	Grasslands 20	0.49	Y	0.5	-	L	Y	N
Lousignot	Vesper Spur 16850	0.09	-	-	-	H	Y	N
Beneke	Beneke Vacated 1	0.30	-	-	-	H	Y	N
Sager	Deep Creek	0.21	-	-	-	H	N	N
Hamilton	Tidewater Loop Spur A	0.56	-	-	1	M	N	N
Hamilton	Tidewater Loop 80	0.25	-	-	1	M	N	N
Wheeler	Section 10	1.53	-	-	2	M	Y	N
Buster	Grand Rapids	1.53	-	-	2	M	Y	N
Hamilton	Ebsen	0.19	-	-	2	M	Y	N
Hamilton	Wooden	0.07	-	-	2	M	Y	N
Northrup	Foster 2010	0.47	-	-	2	M	Y	N
Lousignot	Vesper Spur 16850	0.44	-	-	2	M	N	N
Buster	Osweg 1010	0.04	-	-	2	M	N	N
Beneke	Sarajarvie Creek	0.33	-	-	2	M	N	N
Buster	Osweg 10	0.37	-	-	2	M	N	N
Crawford	Crawford Ridge 14010	0.75	-	-	2	M	N	N

Table 14-3. Streams crossings in the Upper Nehalem project area prioritized for repair based on fish passage condition, crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

			Fish Passage					
Management Basin	**Road Name**	**Crossing Location (Road Mile)**	**Known Juvenile Barrier**	**Stream Length Upstream of Barrier (Mi)[1]**	**AP Code[2]**	**Washout Hazard Rating**	**SAH[3]**	**Sediment Concern**
Hamilton	Fishhawk Creek 1010	0.03	-	-	2	M	N	N
Hamilton	Tidewater Loop 110	0.79	-	-	2	M	N	N
Hamilton	Tidewater Loop 80	0.18	-	-	2	M	N	N
Hamilton	West Tidewater	0.72	-	-	2	M	N	N
McGregor	Music	2.03	-	-	2	M	N	N
Buster	Wage 90 Vacated	0.14	-	-	2	L	Y	N
McGregor	Pit	0.97	-	-	2	L	Y	N
Sager	Walker Ridge	1.96	-	-	2	L	Y	N
Sager	West Sager Creek 120	0.17	-	-	2	L	N	N

1 The stream length upstream of barriers represents stream mileage up to the current upstream extent of passage on each stream.

2 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.

AP code 1 indicates the crossing is in failure

AP code 2 indicates the crossing is nearing failure.

3 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

14.2.3 Fish Presence Verification

A total of 25 stream crossings were identified to restrict adult and juvenile fish passage on streams with likely fish presence (Table 14-4). Likely fish presence indicates that a stream exhibits habitat conditions determined likely to support fish populations, but fish presence surveys have not yet been conducted on the stream. Likely barrier crossings were not prioritized other than by passage restriction type.

Table 14-4. Streams crossings in the Upper Nehalem project area identified as adult and juvenile barriers on streams with likely fish presence and their presence in Salmon Anchor Habitats (SAH).

Management Basin	Road Name	Crossing Location (Road Mile)	Likely Fish Barrier Type	SAH[1]
Wheeler	Clarkson Creek	0.96	Adult/Juvenile	Y
Wheeler	Fire Road 1	1.19	Adult/Juvenile	Y
Wheeler	Salmonberry	0.07	Adult/Juvenile	N
Quartz	August Fire	3.48	Adult/Juvenile	N
Buster	Soak Alley 20	0.42	Adult/Juvenile	N
Crawford	Squaw Creek	1.29	Adult/Juvenile	N
Hamilton	Tidewater Loop	2.57	Adult/Juvenile	N
Hamilton	Tidewater Loop	3.49	Adult/Juvenile	N
Hamilton	Wooden 10	0.02	Adult/Juvenile	N
Hamilton	West Tidewater	0.01	Adult/Juvenile	N
Wheeler	Clarkson Creek	1.02	Juvenile	Y
Wheeler	Marshall	0.03	Juvenile	Y
Wheeler	South Lousignont	2.98	Juvenile	Y
Wheeler	Round Top	0.57	Juvenile	Y
Quartz	Sterling Ranch	0.79	Juvenile	Y
Quartz	Sterling Ranch 10	0.18	Juvenile	Y
Buster	Nettle Creek	1.06	Juvenile	Y

Table 14-4. Streams crossings in the Upper Nehalem project area identified as adult and juvenile barriers on streams with likely fish presence and their presence in Salmon Anchor Habitats (SAH).

Management Basin	Road Name	Crossing Location (Road Mile)	Likely Fish Barrier Type	SAH[1]
McGregor	North Fork Wolf Creek	3.16	Juvenile	N
Hamilton	Fishhawk 10	0.06	Juvenile	N
Beneke	Sarajarvie Creek 40	0.70	Juvenile	N
Beneke	Sarajarvie Creek 40	.028	Juvenile	N
Beneke	Wild Goose Ridge 20	2.27	Juvenile	N
Northrup	Northrup Creek	1.92	Juvenile	N
Wilark	Beaver Home	0.05	Juvenile	N
Wilark	Beaver Home	0.52	Juvenile	N

1 The stream length upstream of barriers represents stream mileage up to the current upstream extent of passage on each stream.

2 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.

AP code 1 indicates the crossing is in failure

AP code 2 indicates the crossing is nearing failure.

3 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

15. SUMMARY/SYNTHESIS

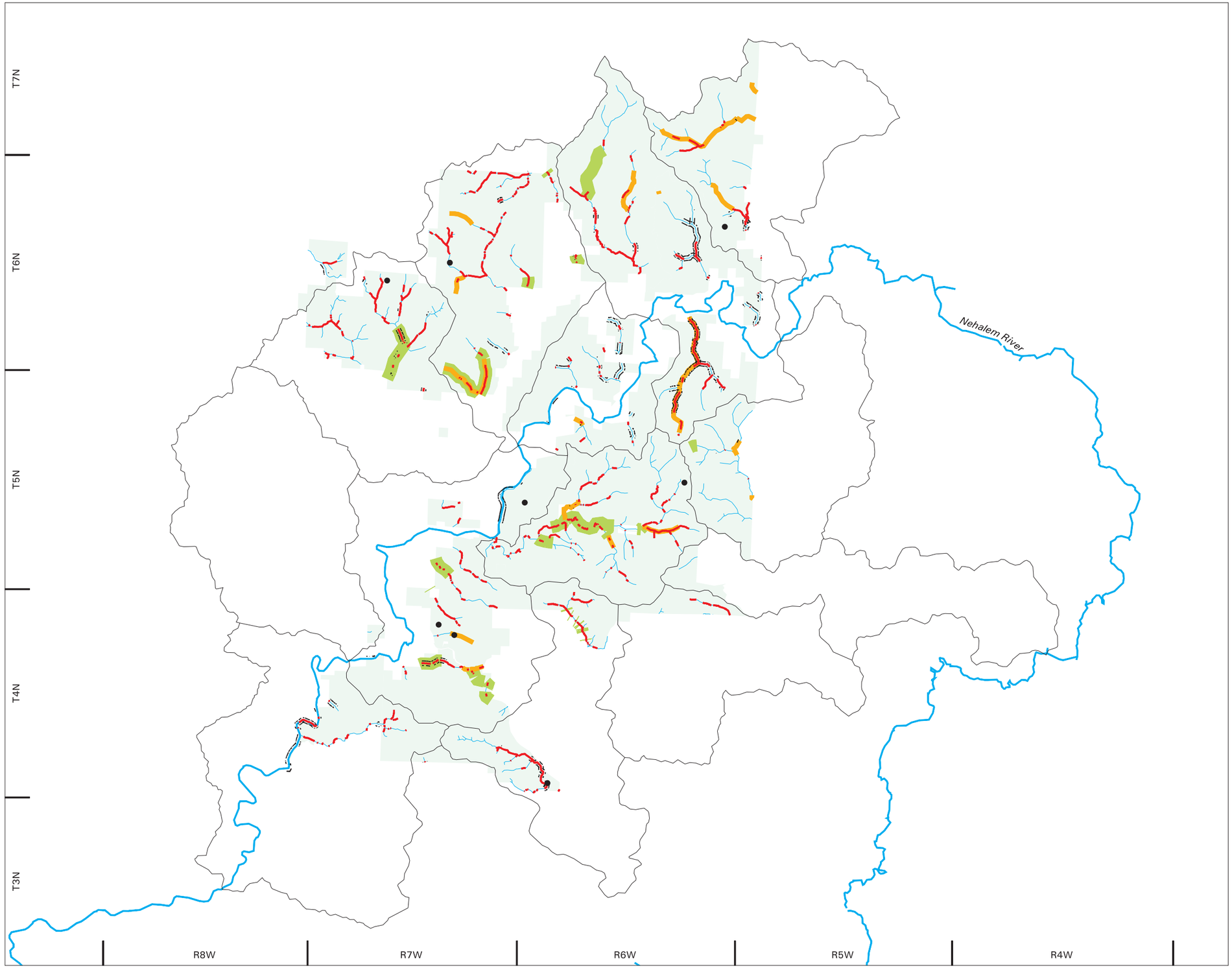
The summary portion of the Watershed Analysis document addresses habitat conditions described in the assessment and analysis phases (Parts I and II) as they relate to the utility and quality of aquatic and riparian habitat. This chapter subsequently addresses forest management considerations to facilitate attaining desired future habitat conditions in a timely fashion. The Summary Section is organized: (1) to identify areas where resource conditions were consistent with the range of variation typically found under natural disturbance regimes for the watershed (defined in the Northwest Oregon Forest Management Plan [NW FMP; ODF 2001] as properly functioning habitat conditions (PFC); (2) to anticipate where conditions in the basin were on a likely trajectory to achieve PFC in a timely fashion under future FMP or SAH management scenarios; and (3) to assess what factors or physical processes in the basin may be limiting the ability to readily achieve PFC.

The information generated within the individual disciplines (e.g., sediment sources, water quality, fish habitat, etc.) was combined to synthesize how management projects to improve habitat conditions should be prioritized. Conclusions for each of the scientific disciplines have been provided in the individual Chapters in the Assessment and Analysis including Hydrology (Chapter 5), Riparian (Chapter 6), Non-road sediment sources (Chapter 7), Road sediment sources (Chapter 8), Water Quality (Chapter 9) and Fish Habitat (Chapter 10). Analyses and a discussion of watershed processes affecting fish habitat are summarized in Limiting Factors (Chapter 11).

Deliverability of input variables (including fine and coarse sediment, heat, and large wood) to the stream channel network and public resources was evaluated to determine if the resource situation was expected to differ from representative conditions under natural disturbance regimes for the watershed (PFC). Specific reach locations where conditions were identified as needing improvement or potentially limiting achievement of PFC were identified as an area of resource sensitivity (ARS) if a link from management activities on the hillslope to aquatic resources in the channel network could be delineated (Figures 15-1a,b).

15.1 MANAGEMENT CONSIDERATIONS

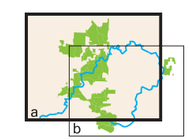
Overall, ODF lands in the upper Nehalem watershed are being managed effectively to address key issues affecting water quality and aquatic life. ODF has a well-designed road system and most human-induced fish barriers have been addressed. Where timber harvest occurs, wide riparian management areas are left along all fish-bearing and perennial flowing streams in



Legend

- Road Repair
- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- High Fine Sediment Deposition (fines > 30%)
- Moderate to High Probability Risk of Achieving PFC for Water Temperature
- Low Wood Recruitment Potential
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.7 Miles

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Miles

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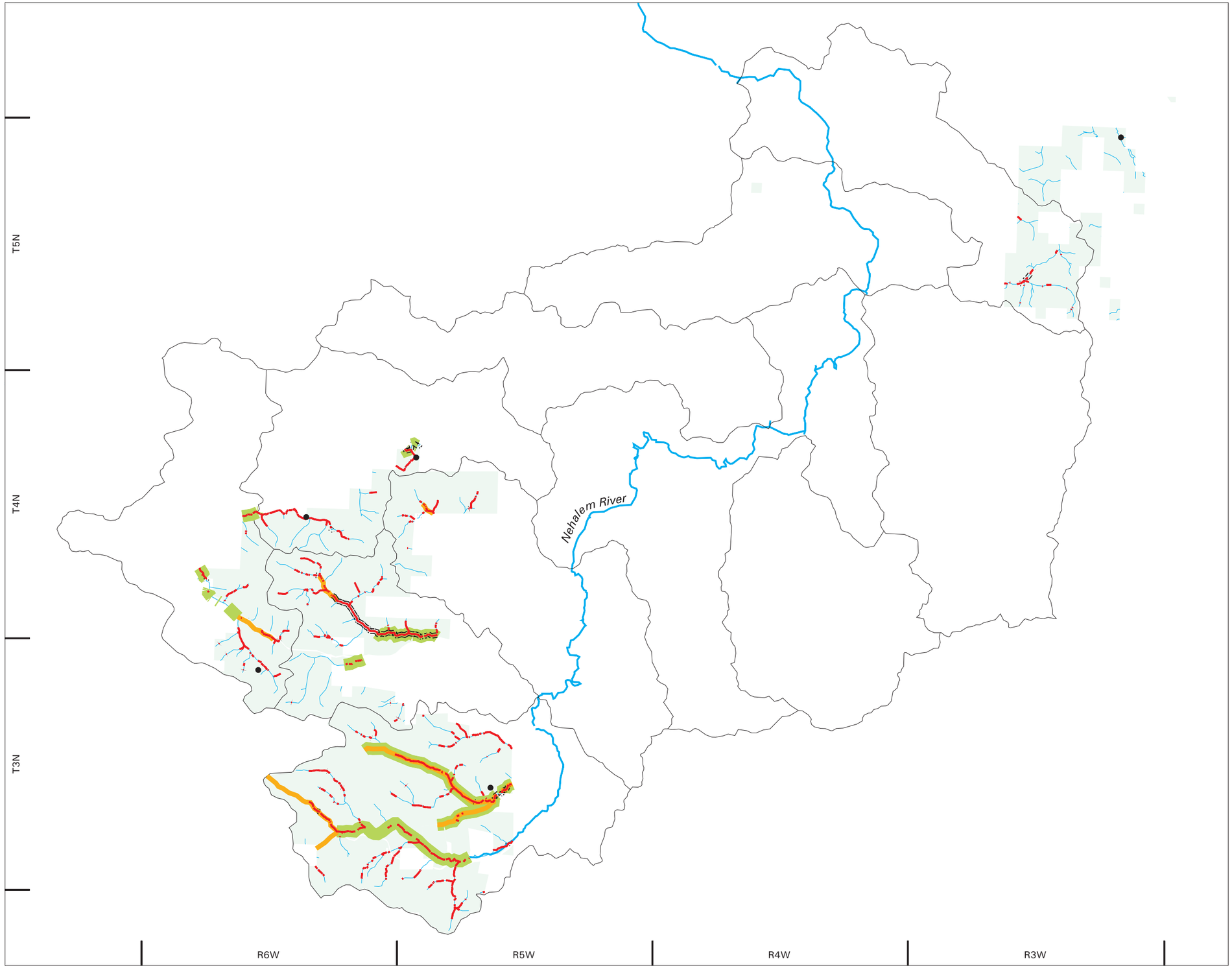
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 15-1(a)

Areas of Resource Sensitivity

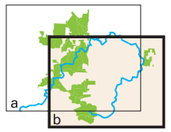
Astoria District



Legend

- Road Repair
- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- High Fine Sediment Deposition (fines > 30%)
- Moderate to High Probability Risk of Achieving PFC for Water Temperature
- Low Wood Recruitment Potential
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 15-1(b)

Areas of Resource Sensitivity

Forest Grove District

accordance with NW FMP and SAH strategies. Prior forest practices have adversely influenced water quality and aquatic life. Information from this analysis provides a framework for understanding both positive and negative aspects of current management on the landscape. It also helps identify opportunities to protect and improve stream and riparian habitats.

The discussion under "Management Considerations" addresses the suite of recommendations for alternative measures and prioritizes the actions with respect to the greatest perceived potential influence on aquatic and riparian resources in the upper Nehalem watershed (Table 15-1). The priority scheme includes numeric codes from 1 to 4 representing the highest to lowest priority. Each of the watershed analysts has independently designed an appropriate priority system specific to evaluate the habitat factor of interest. In this section, the priorities are combined and based on our professional opinion we have integrated the independent scales to generate the effort resulting in the likely greatest benefit to the resources. Where priorities are equal, we gave greater weighting to recommended measures along streams located in SAH sub-watersheds, since they have been designed to protect critical anadromous salmonid habitats with an objective of improving habitat conditions in a 10-year period.

The following management considerations represent strategies to achieve and maintain PFC for aquatic and riparian resources that are not anticipated to occur under the current management strategies for the NW FMP and for SAHs.

15.1.1 In-Channel Habitat Conditions:

Channel habitat data collected under ODFW's aquatic inventory project (AIP) indicated site-specific reaches: (1) lacking key piece-size large wood (> 24 in. diameter) and (2) where fine sediment levels exceeded an estimate of historic sediment loading under routine channel conditions (Figure 15-1a,b). Although sources and management considerations for sediment and wood in the watershed are discussed separately below, they work cooperatively together in the channel to form or modify aquatic habitats.

Large Wood: Areas shown on Figure 15-1a,b where in-channel wood was currently low, combined with riparian characteristics that offered low long-term recruitment potential represent locations in the watershed where opportunities exist for the addition of log structures or boulder clusters to enhance habitat complexity. Specific areas were identified where both ARS features overlapped and short-term and long-term restoration recommendations based on specific riparian stand situations [**#1 Vegetation Composition**: Riparian zone dominated by bare ground, grasses, shrubs; **#2 Riparian Structures/Development**: Encroachment of road and rail line

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
Astoria						
	Beneke					
		Beneke Cr.	Stream Crossing	Beneke Vacated 1 @ 0.30	1	High washout hazard
		Gilmore Cr.	Large Wood		2	Low in-stream wood; low recruitment potential scenario #3b, 4.
		Gilmore Cr. Tributary A	Large Wood		2	Low in-stream wood; low recruitment potential scenario #3b, 4.
	Buster	Unnamed Trib to Walker Cr.	Fish Passage Barrier	RM 0.2; Grasslands 20 @ mile 0.49	1	Juvenile barrier blocking 0.5 miles; replacement; sediment concern; SAH
		Buster Creek	Large Wood		1	Low in-stream wood; low recruitment potential scenario #3a, 3b, 4; SAH
		Osweg Cr.	Stream Crossing	Osweg 10 @ mile 0.28	3	AP code 2 with high washout hazard; low sediment concern
	Fishhawk	Fishhawk Cr.	Water Temperature	Fishhawk Lake to Confluence	4	Shallow reservoir heating; not forest management related.
		Warner Cr.	Water Temperature	Warner Creek Confluence	2	Based on stream length influenced; Riparian Restoration Strategy #4
	Hamilton	Hamilton Cr.	Large Wood		3	Low in-stream wood; low recruitment potential scenario #3b, 4.
			Stream Crossing	Tidewater Loop @ mile 3.49	2	AP code 2 with high washout hazard; low sediment concern
	Lousignot		Stream Crossing	Vesper Spur 16850 @ mile 0.09	1	High washout hazard; sediment concern

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
	Northrup	Northrup Cr.	Large Wood	RM 4.0	3	Low in-stream wood; low recruitment potential scenario #4 - hardwood; headwater location
		Cow Cr.	Fine Sediment	ODFW Reach 28	4	1.6 mi., (high fines, but no obvious management sources)
	Quartz	Rock Cr.	Water Temperature	RM 26.5 - 27.0	1	0.5 mi. Riparian Restoration Scenarios #1, 2, 4; SAH
		Klines Cr.	Large Wood	0.6 mi.	3	Low in-stream wood; low recruitment potential scenario #4 - hardwood
		Quartz Cr.	Large Wood		3	Low in-stream wood; low recruitment potential scenario #4 - hardwood
		Quartz Cr.	Water Temperature		2	0.8 mi. Riparian restoration strategy #4.
		Mainstem Nehalem River	Water Temperature	Near Spruce Run Cr. Confluence	4	2.0 mi. Riparian restoration strategy #3b, 4
	Sager	Sager Creek	Fine Sediment	Sager Cr. Road @ mile 0.38	2	0.28 mi. parallel road, hydrological connection; sediment sources
		Sager Creek	Water Temperature		2	0.5 mi. Riparian Restoration Scenarios #3a – Sparse Hardwood;
		Deep Creek	Stream Crossing	Deep Creek @ mile 0.21	1	High washout hazard
			Stream Crossing	Grand Rapids 601030 @ mile 0.19	3	AP code 2 with high washout hazard; low sediment concern
Forest Grove						
	McGregor	NF Wolf Cr.	Large Wood		2	Low in-stream wood; low recruitment

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
						potential scenario #4 - hardwood
		Bear Creek Trib to SF Rock Cr.	Fine Sediment	Section 10 Road @ mile 3.33	2	0.52 mi. Stream parallel road; hydrological connection sediment sources; SAH
		SF Rock Creek	Large Wood		1	Low in-stream wood; low recruitment potential scenario #4 - hardwood; SAH
	Wheeler	Unnamed Trib. to Lousignont Cr.	Fish Passage Barrier	RM 0.5; North Lousignont @ 4.4	1	Juvenile barrier blocking 3.7 miles; sediment concern; SAH
		Lousignont Cr.	Water Temperature		1	0.4 mi. riparian restoration scenario #1; SAH
		Lousignont Cr.	Large Wood		1	Low in-stream wood; low recruitment potential scenario #1, 2, 4; SAH
		Lousignont Cr.	Fine Sediment	Marshall Road mile 0.03	2	0.51 mi. Stream parallel road; hydrological connection sediment sources; SAH
		Carlson Cr. trib to Lousignont Cr.	Fine Sediment	Clarkson Creek road mile 1.02; Clarkson Cr. Spur 0.44 mi at road mile 0.21	2	1.14 mi. Stream parallel roads; hydrological connection; sediment sources; SAH
		Doty Cr.	Water Temperature		2	0.1 mi. riparian restoration scenario #4; SAH but small stream length influenced
		Upper Nehalem River	Large Wood		1	Low in-stream wood; low recruitment potential scenario #1, 3b, 4; SAH
		SF Nehalem River	Fine Sediment	ODFW Reach 154	4	0.5 mi. (Fines); SAH: but no obvious management sources
	Wilark	Oak Ranch Cr.	Fish Passage Barrier	RM 7.0; Oak Ranch @	1	Juvenile barrier blocking 14.4 miles

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
				0.12 mi.		
		Little Clatskanie River	Stream Crossing	Little Clatskanie @ 0.38 mi.	2	AP code 1 with high washout hazard; low sediment concern

structures within the 100-ft riparian zone; **#3 Sparse Levels of Stocking in Stands**: Sparse hardwood, mixed species and conifer stands that preclude development of a second cohort; and **#4 Hardwood Senescence**: Dense hardwood stands (HMD and HSD) that become sparse due to future mortality, yet preclude development of a second cohort] were identified (Figure 12-2). Streams with riparian restoration recommendations are listed below.

1) Headwaters of Nehalem River
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #1, 3b, 4
    c. Priority: (1) based on SAH sub-watershed

2) Buster Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3a, 3b, 4
    c. Priority: (1) based on SAH sub-watershed

3) SF Rock Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (1) based on SAH sub-watershed

4) Lousignont Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #1, 2, 4
    c. Priority: (1) based on SAH sub-watershed

5) Gilmore Creek and Gilmore Tributary A
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3b, 4
    c. Priority: (2) based on length of channels in low condition

6) NF Wolf Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (2) based on length of channel in low condition

7) Mainstem Hamilton Creek:
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3b, 4
    c. Priority: (3) based on small area influenced

8) Northrup Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

9) Klines Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

10) Quartz Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

ODF and ODFW have a long history of cooperatively performing in-stream enhancement projects to improve habitat complexity. The working procedures from both agencies should be used to facilitate such projects based on the priority status included above.

Fine Sediment: Specific channel reaches shown on Figure 15-1a,b where instream fine sediment levels (> 2mm size fractions) exceeded estimates of historic sediment loading in combination with ODF hydrologically-connected roads that offered a potential sediment concern (Table 14-1) represent locations in the watershed where opportunities exist for source reductions from road surfaces. Specific areas where both ARS features overlap and potential restoration recommendations have been identified and prioritized in Chapter 14 and are summarized below. All of these situations, with the exception of Sager Creek, are included in Salmon Anchor Habitat sub-watersheds and received a top priority for road attention.

1) Bear Creek (Tributary to SF Rock Creek)
    a. Road Name: Section 10
    b. Segment length: 0.52 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

2) Lousignont Creek
    a. Road Name: Marshall
    b. Segment length: 0.51 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

3) Carlson Creek (Tributary to Lousignont Creek)
    a. Road Name: Clarkson Creek Spur 0.44 mi.
    b. Segment length: 0.73 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

4) Carlson Creek (Tributary to Lousignont Creek)
    a. Road Name: Clarkson Creek
    b. Segment length: 0.41 mi.
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

5) Sager Creek
    a. Road Name: Sager Creek
    b. Segment length: 0.28 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern

ODF should also consider implementing restoration opportunities listed in the ODFW habitat survey report (as cited in Kavanagh et al. 2005) as per the reaches in Table 15-2.

15.1.2 Alternative Vegetation Management

The following alternative vegetation management strategies were discussed in Chapter 12 to address specific riparian stand characteristics that were not anticipated to achieve PFC in a 100-year time frame.

The recommendations for alternative vegetation management were specific to stand situations predicted to inhibit development of PFC under the proposed management scenarios (Figure 12-2a,b).

Vegetation Composition: Riparian zone dominated by bare ground, grasses, shrubs.

Riparian Structures/Development: Encroachment of road and rail line structures within the 100-ft riparian zone.

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent		Resource Concern	Miles Affected
									From	To		
South Fork Rock Creek	2200	7216	Medium	1	H	yes	X	FG	HWY 26	Shields Rd	Large wood	0.8
South Fork Rock Creek	1780	5840	Medium	1	H	yes	X	FG	Mouth	HWY 26		
Olson Creek	1274	4178	Medium	2	M		X	FG	Rock Creek	End of Coho		
Rock Creek	1832	6010	Large	2	M	yes	X	FG	North Fork Rock Creek	TJ/		
Rock Creek Trib C	401	1317	Medium	2	M		X	AST	Rock Creek	End of Coho	Replaced culverts	1.5
Wolf Creek	5200	17057	Large	2	H		X	FG	Nehalem River	North Fork Wolf Creek		
Wolf Creek	1429	4867	Medium	2	M		X	FG	North Fork Wolf Creek	Wolf Creek Falls		
North Fork Wolf Creek	4213	13820	Medium	2	M	yes	X	FG	Wolf Creek	End of Coho	Large wood	1.0
North Fork Wolf South Trib	1602	5253	Medium	2	U			FG	North Fork Wolf Creek	Endo of Coho		
North Fork Wolf Creek Trib B	1375	4512	Medium	2	M			FG	North Fork Wolf Creek	End of Coho		
North Fork Wolf Creek Trib B	86	281	Medium	2	M			FG	North Fork Wolf Creek	End of Coho		
Lousignont Creek (Timber)	1998	6555	Medium	2	M	yes	X	FG	Carlson Creek	End of Coho	Large wood	2.0
Lousignont Creek (Timber)	1704	5588	Medium	2	H	yes	X	FG	Carlson Creek	End of Coho	Large wood	
North Fork Lousignont Creek	3402	11159	Medium	2	M		X	FG	Lousignont Creek	Endo of Coho		
South Fork Lousignont Trib A	1104	3622	Medium	2	U			FG	South Fork Lousignont Creek	End of Coho		
Nehalem River	2158	7077	Medium	2	M	yes	X	FG	Hans Creek	End of Coho		
South Fork Nehalem River	1343	4405	Medium	2	M	yes	X	FG	Hans Creek	End of Coho		
Step Creek	536	1758	Medium	2	M		X	FG	Nehalem River	End of Coho		
Nehalem River	422	1385	Medium	3	L	yes	X	FG	Hans Creek	Endo of Coho (Doty Pond?)		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent		Resource Concern	Miles Affected
									From	To		
Upper Nehalem River Trib B	598	1963	Medium	3	L			FG	Nehalem River	End of Coho		
Selder Creek	1859	6099	Medium	4	N			AST	Rock Creek	End of Coho		
Olson Creek	832	2730	Medium	4	N		X	FG	Rock Creek	End of Coho		
North Fork Rock Creek	1950	6395	Medium	4	N	yes	X	AST	Large TJ/	End of Coho		
North Fork Rock Creek Trib B	1096	3596	Medium	4	N			AST	Mouth	Endo of Coho		
South Fork Rock Creek	1001	3284	Medium	4	N	yes	X	FG	Above Shields Rd	End of Coho		
Bear Creek (Rock Creek)	1622	5319	Medium	4	H	yes	X	FG	South Fork Rock Creek	End of Coho		
North Fork Wolf Creek	1429	4688	Medium	4	N	yes	X	FG	Wolf Creek	End of Coho		
Lousignont Creek (Timber)	1528	5013	Medium	4	N	yes	X	FG	North Fork Lousignont Creek	Carlson Creek		
Carlson Creek	1567	5138	Medium	4	M	yes	X	FG	South Fork Lousignont Creek	End of Coho		
Carlson Creek	914	2999	Medium	4	N	yes	X	FG	South Fork Lousignont Creek	End of Coho		
Nehalem River	6869	22530	Large	4	U			FG	Castor Creek	Step Creek		
Nehalem River	756	2480	Large	4	M	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	972	3189	Large	4	M	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	1500	4918	Medium	4	N	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	875	2869	Medium	4	N	yes	X	FG	Hans Creek	End of Coho (Doty Pond?)		
Step Creek	972	3189	Medium	4	N			FG	Nehalem river	End of Coho		
Derby Creek	280	917	Medium	4	N			FG	Nehalem River	End of Coho		
East Humbug Creek	3428	11245	Medium	1	H		X	AST	1st Rd X-ing	End of Road Access		
Buster Creek	1789	5866	Medium	1	H		X	AST	Walker Creek	Stanley Creek		
Buster Creek	3280	10758	Medium	1	H		X	AST	Stanley Creek	End of Road Access		
Walker Creek	5892	19326	Medium	1	H	yes	X	AST	2nd Walker CR RD X-ing	End of Road Access	Culvert replaced	0.1
East Humbug Creek	1738	5699	Medium	2	U			AST	End of Road Access	End of Coho		
Quartz Creek	1985	6511	Medium	2	U	yes		AST	Nehalem River	High Gradient Reach		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent		Resource Concern	Miles Affected
									From	To		
										Below S FK		
SF Quartz Creek			Medium									
Moores Creek	655	2150	Medium	2	H	yes			Nehalem River	End of Coho	Culv. Removed, road vacated	0.2
Buster Creek	888	2914	Medium	2	M		X	AST	End of Lower Rd Access	End of Coho	Culvert replaced	1.0
Walker Creek (Buster Creek)	1253	4111	Medium	2	M		X	AST	Buster Creek	TJ Upstream of Wage Rd		
Stanley Creek	1259	4131	Medium	2	U			AST	Buster Creek	End of Coho		
Hamilton Creek	3399	11149	Medium	2	M	yes	X	AST	Fishhawk Creek	End of Road Access	Culvert replaced	1.9
Grub Creek	950	3115	Medium	2	U			AST	Nehalem River	End of Coho		
Squaw Creek	4495	14745	Medium	2	U			AST	Nehalem River	End of Coho	Culvert removed	1.1
West Branch Squaw Creek	1248	4095	Medium	2	U			AST	Squaw Creek	End of Coho		
Northrup Creek	709	2324	Medium	2	H		X	AST	ODF Boundary	Cow Creek	Culvert replaced	0.2
Northrup Creek	5912	19391	Medium	2	M		X	AST	Cow Creek	End of Coho	Large wood	1.5
Sager Creek	2513	8241	Medium	2	M	yes	X	AST	Nehalem River	East Sager Creek		
East Sager Creek	1696	5564	Medium	2	M		X	AST	Sager Creek	End of Coho	Culv. Removed, road vacated	1.0
Deep Creek	403	1322	Medium	2	U		X	AST	TJ AT T6N-R6W-12	End of Coho		
Deep Creek	3099	10165	Medium	2	U	yes		AST	TJ/ AT T5N-R5W 19NW	TJ at End of Deep Creek Rd		
Deep Creek Trib C	402	1319	Medium	2	U			AST	TJ AT T6N-R6W-12	End of Coho		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent		Resource Concern	Miles Affected
									From	To		
Warner Creek	1515	4970	Medium	2	U	yes		AST	Fishhawk Creek	End of Coho	Culvert replaced	2.5
Buster Creek Trib A	167	547	Medium	3	H			AST	Buster Creek	End of Coho	Culver replaced	0.3
Beneke Creek	1609	5279	Medium	3	L		X	AST	Bull Heifer Creek	TJ AT T6N-R7W-11C		
Cow Creek	2908	9537	Medium	3	H		X	AST	Northrup Creek	200M above Cow Cr Road	Culverts replaced	3.9
Cow Creek (Vinemaple)	1383	4537	Medium	4	N	yes	X	AST	End of Road Access	End of Coho (falls)		
Klines Creek (South)	1107	3630	Medium	4	N	yes	X	AST	Nehalem River	End of Coho		
Buster Creek	3844	12607	Large	4	U		X	AST	Nehalem River	/TJ AT T5N-R6W-30NW		
Buster Creek	2783	9128	Medium	4	N		X	AST	End of Lower Rd Access	End of Coho		
Buster Creek Trib B	1908	6257	Medium	4	N			AST	Buster Creek	End of Coho		
Buster Creek Trib C	1077	3532	Medium	4	N			AST	Buster Creek	End of Coho (below Rd x-ing)		
Walker Creek (Buster Creek)	2014	6606	Medium	4	N		X	AST	Walker Creek	End of Coho		
Walker Creek (Buster Creek) Trib	1473	4832	Medium	4	N		X	AST	Walker Creek	End of Coho		
Hamilton Creek	2302	7551	Medium	4	N	yes	X	AST	End of Road Access	End of Coho		
Beneke Creek	5163	16934	Large	4	H	yes	X	AST	Gilmore Creek	Walker Creek		
Beneke Creek	1600	5249	Medium	4	N			AST	End of Road Access	Bull Heifer Creek		
Bull Heifer Creek	500	1640	Medium	4	N			AST	Beneke Creek	End of Coho		
Beneke Creek	222	729	Medium	4	N			AST	Bull Heifer Creek	TJ AT T6N-R7W-11C		
Gilmore Creek			Medium									
Gilmore Creek Trib A	1929	6326	Medium	4	N			AST	Gilmore Creek	End of Coho		
Trailover Creek	1645	5395	Medium	4	N	yes		AST	Walker Creek	End of Coho		
Walker Creek	2712	8896	Medium	4	N			AST	/TJ AT T5N-R6W-20	End of Coho		
Walker Creek	6001	19682	Medium	4	N	yes	X	AST	End of Road Access	End of Coho		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent		Resource Concern	Miles Affected
									From	To		
Crawford Creek	1343	4403	Medium	4	N			AST	Nehalem River	End of Coho		
Grub Creek	1336	4383	Medium	4	N			AST	Nehalem River	End of Coho		
Nehalem River Trib B	756	2478	Medium	4	N			AST	Nehalem River	End of Coho		
Northrup Creek	576	1889	Medium	4	N		X	AST	Cow Creek	End of Coho		
Cow Creek	1907	6256	Medium	4	N		X	AST	200M above Cow Cr Rd	End of Coho		
Sager Creek	2854	9360	Medium	4	N	yes	X	AST	East Sager Creek	End of Coho		
Lousignont Creek (Birkenfeld)	4233	13884	Medium	4	N			AST	Nehalem River	End of Coho		
Deep Creek	1287	4223	Medium	4	N			AST	TJ AT T6N-R6W-12	End of Coho		
Deep Creek Trib B	3179	10427	Medium	4	N			AST	Deep Creek	End of Coho		
Deep Creek Trib C	804	2638	Medium	4	N			AST	TJ AT T6N-R6W-12	End of Coho		
Fishhawk Creek (Birkenfeld)	3116	10222	Large	4	H		X	AST	End of Ag Land Use	Fishhawk Lake	Off Channel, Riparian, Culvert	0.4
Warner Creek	680	2232	Medium	4	N	yes		AST	Fishhawk Creek	End of Coho		
Slaughters Creek	1536	5039	Medium	4	U			AST	Nehalem River	End of Coho		
West Branch Squaw Creek	635	2083	Medium	4	N			AST	Squaw Creek	End of Coho		
Oak Ranch Creek	3287	10781	Medium	1	H	yes	X	FG	Rock Pit above Apiary Rd X	Camp Wilkerson		
Oak Ranch Creek	2502	8207	Medium	2	U	yes	X	FG	Camp Wilkerson	TJ AT T5N-R3W-21NW		
Oak Ranch Creek	1518	4979	Medium	2	U			FG	TJ AT T5N-R3W-21NW	End of Coho		
Oak Ranch Creek	902	2957	Medium	4	N		X	FG	Camp Wilkerson	TJ AT T5N-R3W-21NW		
Pebble Creek	2162	7091	Medium	4	N		X	FG	West Fork Pebble Creek	End of Coho		
Dell Creek	1810	5936	Medium	4	N	yes		FG	Pebble Creek	End of Coho		
Nettle Creek												
Osweg Creek												

Sparse Levels of Stocking in Stands: Sparse hardwood, mixed species and conifer stands that preclude development of a second cohort.

Hardwood Senescence: Dense hardwood stands (Riparian codes HMD and HSD) that become sparse due to future mortality, yet preclude development of a second cohort.

Large Wood: Areas shown on Figure 15-1a,b where in-channel wood was low in combination with riparian characteristics that offered low wood recruitment potential were addressed in Section 15.1.1 above.

Shade/Water Temperature: Locations on ODF lands in the watershed where opportunities exist for the alternative vegetation measures to address a moderate to high probability of not achieving PFC for water temperature in 100 years are shown on Figures 12-3a,b. Long-term restoration recommendations for key areas based on stream length and specific riparian stand situations are listed below and in Table 15-1. The recommendations of appropriate management actions per riparian stand scenario have been outlined in Section 12.1.3.

1) Doty Creek (Tributary to upper Nehalem River)
    a. Long-term: Riparian Restoration Scenarios #4 – Hardwood
    b. Priority: (1) based on SAH sub-watershed

2) Lousignont Creek (downstream of Carlson Creek)
    a. Long-term: Riparian Restoration Scenarios #1 – Shrub, grasses
    b. Priority: (1) based on SAH sub-watershed

3) Upper Rock Creek
    a. Long-term: Riparian Restoration Scenarios #1, 2, 4
    b. Priority: (1) based on SAH sub-watershed

4) Sager Creek
    a. Long-term: Riparian Restoration Scenarios #3a – Sparse Hardwood
    b. Priority: (2) based on stream length influenced

5) Warner Creek (Tributary to Fishhawk Cr.)
    a. Long-term: Riparian Restoration Scenarios #4 - Hardwood
    b. Priority: (2) based on stream length influenced

6) Quartz Creek
    a. Long-term: Riparian Restoration Scenarios #4 - Hardwood
    b. Priority: (2) based on stream length influenced

7) Mainstem Nehalem River (near confluence of Spruce Run Cr.)
    a. Long-term: Riparian Restoration Scenarios #3b, 4
    b. Priority: (4) channel width, elevation and distance from divide make alternative riparian restoration measures unlikely to modify stream temperatures at this location

Other scattered sections of stream reaches with moderate or high probability of not achieving PFC for water temperature in the 100-year time frame exist throughout the ODF land as shown in Figure 12-3a,b. However, the reaches are of small magnitude and overall they represent a low probability for a measurable influence on aquatic resources in the watershed. Alternative vegetation management measures for these areas are rated with a low priority (4).

Road Management Considerations

ODF road improvements to minimize potential road-related risks to aquatic and riparian resources in the upper Nehalem watershed have been discussed in Chapter 14. A total of 85 road segments, 25 road crossings and 3 fish passage barriers have been prioritized for future management actions. Management actions were prioritized based on ODF road drainage and prism "attention priority" (AP) codes, hydrologic connection of road drainages, critical road locations, proximity to high in-channel sediment loads, stream crossing hazard ratings, washout hazard ratings and fish passage concerns. The highest priority road-related projects have been integrated with other areas of resource sensitivity in Table 15-1.

15.2 CRITICAL QUESTION RESPONSE SUMMARY

OWEB Critical and ODF Supplemental Questions

This Chapter provides a brief summary to the questions used to develop the upper Nehalem Watershed Assessment where feasible. For detailed or lengthy answers, the location within the document where answers can be found is provided.

Historical Assessment

OWEB Critical Questions

1. What were the characteristics of the watershed's resources at the time of European exploration/settlement?

A discussion of the watershed at the time of European settlement can be found in Section 3.1.1.

2. What are the historical trends and locations of land use and other management impacts in the watershed?
Historic trends in land use and management are discussed in 3.1.4.

3. What are the historical accounts of fish populations and distribution?
An historic account of fish populations can be found in Section 3.1.3

4. Where are the locations of historic floodplain, riparian area, channel, and wetland modifications, and what was the type and extent of the disturbance?
A discussion of historic floodplain and channel modifications can be found in Section 4.3.1. A discussion of historic land clearing for agriculture, timber management can be found in Sections 3.1.2.

ODF Supplemental Questions

1. What are the natural disturbances and their impacts on the aquatic ecosystem prior to and shortly after European Settlement, as well as through recent times?
A discussion of the natural disturbance regime for floods, fires and landslides in the Nehalem River can be found in Section 3.2 and Appendix A.

2. What is the early management history of the forestland in the watershed (this would include things like description of salvage logging or replanting of burned areas?
A discussion of early forest management can be found in Section 3.3.

Stream Channels

OWEB Critical Questions

1. What is the distribution of CHT's throughout the watershed?
Twelve distinct channel habitat types were identified within the upper Nehalem Project Area. These channel Types are depicted in Table 4-1. The distribution of channel types on fish bearing streams within the Upper Nehalem Project Area are depicted in Figure 4-1, Appendix I, and are summarized by management basin in Table 4-5.

2. What is the location of CHT's that are likely to provide specific aquatic habitat features?
Specific key aquatic habitat features provided by each CHT are identified in Table 4-4. Absence of a habitat feature for a given CHT implies only that it may be present in relatively low amounts, and does not constitute a significant habitat component. All CHT's provide unique habitat values for various aquatic species. Key aquatic habitat features for anadromous fish include adult holding habitat (i.e., pools > 1 m deep), off-channel rearing habitat (i.e., side channels), and spawning habitat (gravel to cobble size substrate).

3. What is the location of areas that may be the most sensitive to changes in the watershed condition?
Channel habitat types and stream sections within each management basin that are likely to be most sensitive to geomorphic inputs are described in Section 4.3.1.
.
4. Where are channel modifications located?
Locations of channel modification are described by management basin in Section 4.3.1.

5. Where are historic channel disturbances located (for example: splash dams, stream cleaning)?
Locations of channel modification are described by management basin in Section 4.3.1.

6. What CHT's have been impacted by channel modification?
Channel habitat types that have been impacted by channel modification are described by management basin in Section 4.3.1.

Hydrology and Water Use

OWEB Critical Questions

1. What land uses are present in your watershed?
Land uses present in the four subwatersheds of the Nehalem watershed are detailed in Table 5-3. Forestry is the predominant land use in the project area.

2. What is the flood history in your watershed?
A greater than 200-year recurrence interval flood occurred on the Nehalem River in 1996. The Nehalem River near Foss gage read a maximum of 70,300 cfs on February 8, 1996. Other large floods were recorded in 1990, 1972 and 1964.

3. Is there a probability that land uses in the basin have a significant effect on peak flows?
Based on literature review addressing the relationship between forestry practices and peak flows, some probability exists that land management activities in the Nehalem basin have affected peak flows. Given the paucity of flow data within the project area, we were unable to assess how specific land uses, including ODF forestry practices, may have impacted the hydrology of the Nehalem River.

4. Is there a probability that land uses in the basin have a significant effect on low flows?
Based on literature review addressing the relationship between forestry practices and low flows, some probability exists that land management activities in the Nehalem basin have affected peak flows. Given the paucity of flow data within the project area, we were unable to assess how specific land uses, including ODF forestry practices, may have impacted the hydrology of the Nehalem River.

5. For what beneficial use is water primarily used in your watershed?
Our research identified a total of eight ODF water rights within the management basins that are used for forest management and fire protection and fifteen private water rights for domestic and livestock water supply located within the project area.

6. *Is water derived from a groundwater or surface-water source?*
The majority of water used is derived from surface sources (Table 5-7, 5-8) with the exception of two water rights that identify a spring source.

7. What type of storage has been constructed in the basin?
At the time of this report, there were many other small reservoirs and off-channel ponds located throughout the entire Nehalem watershed. The total storage of water was 1273.6 acre feet. This water was used for recreation (77.5%), fish (15.4%), wildlife (5.2%), irrigation (1.4%), and "other" (fire protection, livestock, domestic/non-commercial). There was also an earth dam on Fishhawk Creek that forms Fishhawk Lake. The dam was privately owned by Fishhawk Lake Recreation Club, Inc. and holds 982 acre feet of water for recreational purposes (Johnson and Maser 2000)

8. Are there any withdrawals of water for use in another basin (interbasin transfers)? Is any water being imported for use in the basin?
We were unable to find any evidence of inter-basin transfer or importation of water within the Project Area.

9. Are there any illegal uses of water occurring in the basin?
We were unable to locate documentation that would allow a determination if illegal uses of water occurred within the project areas.

10. Do water uses in the basin have an effect on peak flows?
The small percentage of agriculture/rangeland and urban area in the Nehalem watershed had a low potential of increasing peak stream flows.

11. Do water uses in the basin have an effect on low flows?
The analysis of water rights indicates that water uses in the basin have the potential to significantly impact low flows.

Riparian Conditions and Wetland

OWEB Critical Questions

1. What are the current conditions of riparian areas in the watershed?
A watershed analysis was completed for the Nehalem watershed by Portland State University (PSU) in 2000 (Johnson and Maser 2000). This assessment performed an inventory of riparian conditions based on 1995 aerial photos. The PSU study determined the Upper Nehalem subwatershed (HUC #1710020201) had two reaches with poor riparian conditions; Weed Creek and South Fork Rock Creek. A number of reaches supported narrow riparian buffers including East Fork Nehalem River, and Lower Rock, Beaver, Kist and Lousignont creeks. The balance of the Upper Nehalem typically supported continuous riparian buffers with young trees. According to the PSU inventory, there were concentrations of riparian buffer in poor condition in the Middle Nehalem subwatershed (HUC #1710020202) along Fishhawk and North Fork Fishhawk creeks and along tributaries of the mainstem Nehalem River. The remainder of the subwatershed consisted primarily of young riparian trees, with approximately 50 percent of the buffer strips less than 30 feet wide and widespread interruptions and discontinuities in vegetation along the stream banks. The PSU inventory concluded poor and fair recruitment potential occurred along approximately 30 percent of the streams in both the Upper and Middle Nehalem subwatersheds.

The Upper Nehalem River Watershed Council (UNWC) subsequently developed detailed GIS coverage of existing riparian polygons of various condition codes based on species composition, average stand size (tree diameters) and relative level of density per the OWEB watershed manual guidelines (Watershed Professionals Network 1999). The existing photo-based inventory

quantified current riparian conditions over 305 miles of ODF streams in the Nehalem watershed using 1995 aerial orthophotos. The results were specifically used herein to address the key watershed questions. Current riparian conditions have been summarized for their potential to contribute large wood and shade in Sections 6.1.3 and 6.1.4.

2. How do the current conditions compare to those potentially present or typically present for this ecoregion?
A description of current condition by management basin is presented in Section 6.1.4.1 that compares riparian stand to typical conditions for the ecoregions in the watershed.

3. How can the current riparian areas be grouped within the watershed to increase the understanding of areas needing protection and the appropriate restoration or enhancement opportunities?
Stream reaches needing riparian protection and restoration and enhancement were identified in groups of various stand situations in Chapter 12, as highlighted in Figure 12-2.

4. What is the location and extent of noxious weeds on state forest lands within the watershed?
A discussion of noxious weeds is located in section 6.3.

ODF Supplemental Questions

1. What are the current riparian vegetation characteristics on state forest lands within the watershed?
The data are summarized by riparian stand characteristics for each of the ODF management basins within the upper Nehalem watershed in Section 6.1.4.1 and in Table 6-2. Data are summarized by 6th field HUCs per Management Basin in Appendix B.

2. What riparian areas currently have high, moderate, and low large wood input potential for key conifer pieces (>24-inch conifer)?
Maps of the adequacy of the existing wood recruitment potential from stream adjacent stands are included as Figure 6-1, Appendix I. Specific reaches with low forecasted wood recruitment potential have been identified in Figure 16-1.

3. Which riparian areas will provide high large wood input potential for key conifer pieces under 50- and 100-year scenarios?
The results for potential large wood recruitment are shown in a matrix of stand conditions along a trajectory of 50-yr increments in Table 6-3 and Figures 6-2 and 6-3, Appendix I.

Non-Roads Sediment Sources

ODF Supplemental Questions

1. What is the distribution of slopes prone to shallow, rapidly moving landslides on state forest lands within the watershed?
A detailed discussion on the GIS-based model for landslide potential in the Upper Nehalem watershed is included in Appendix D. A summary description of the model is provided in Section 7.2.1.1. Model predictions referred directly to the likelihood of shallow landsliding on planar and convergent slopes, and on the likelihood of debris flows to scour headwater channels and to deposit sediment and wood into fish bearing channels. Predictions were in terms of landslide density and probability of debris flows.

Maps of the study area and legend for the slope stability and debris flow analysis are shown in Appendix D, Figures D-6 and D-7. The legend is included in Figure 7-1, below. Results of the model predictions for: (1) slope gradient, (2) landslide density, (3) debris flow probability, and (4) debris flow wood recruitment corridors comprise 52 figures and can be found in Appendix D. We selected representative figures to show a range of prediction results. For landslides these data are presented in Figures 7-2 and 7-3.

2. What is the distribution of debris flow-prone channels on state forest lands within the watershed?
The average debris flow probability and debris flow wood delivery corridors can be arrayed according to "likely" through "unlikely" by having those categories span the predicted high – low range of probabilities. Refer to the flowchart in Figure D-5, Appendix D, summarizes a procedure for managing landslide and debris flow risk. This flowchart provides guidance on how to use the four map products developed during this analysis. The maps depicting debris flow-prone channels are shown by management basin in Appendix D. We selected representative figures to show a range of prediction results. For debris flow-prone channels these data are presented in Figure 7-4.

3. Are there locations with gullies or other active surface erosion areas in the watershed?
Based on 2005 road surveys of forest roads in the project area, gullies and other forms of surface erosion was not a significant issue in the Upper Nehalem. Road condition and drainage issues associated with roads are described in Chapter 8, Road-Related Sediments.

4. Are there deep-seated, active, or recently active moving landslides?
The map showing the locations of deep-seated failures in bedrock and hence providing a general guide to this form of mass movement in the Nehalem watershed is Figure D-62 in Appendix D.

5. Are there any unusually prone soils on steep slopes (>79%) in the watershed?
Soil type is likely more important in the process of surface erosion and surface erosion is anticipated to be uncommon in the Nehalem watershed. This assumption is because most forest soils have surface infiltration capacities that exceed rainfall intensities and consequently overland flow is rarely generated.

Road-Related Sediment Sources

ODF Supplemental Questions

1. What proportion of road length is within 100 feet of streams?
Of 607 total miles of forest road in the project area, 53.8 (8.8%) were stream adjacent (Tables 8-1 and 8-2).

2. What proportion of road related drainage ditches are directly connected to the stream network?
Approximately 96 miles, or 15.8 percent, of the total road system had direct hydrological connection to the stream network (Figure 8-1, Appendix I, and Tables 8-3 and 8-4).

3. What roads are in critical locations?
A total of 33.6 miles, or 5.5 percent of forest roads were in critical locations (Table 8-6). The roads with greatest in critical location were Buster Creek Road in the Buster Management Basin, which has 1.76 miles of stream parallel road, and North Lousignont Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads.

4. What roads have road prism instability, including sidecast/fill landslides?
No roads in the project area were identified to have prism AP Code 1. Two road sections are located on sidecast/fill slides: Lower Rock Creek Road and Crawford Ridge 14010. Three road sections were located on fill slides: East Sager Vacated 3, Beneke Vacated 1, and Vesper Spur 16850. See Tables 8-7 and 8-8.

5. How many stream crossings are barriers to fish passage?

A total of three stream crossings were identified as barriers to juvenile fish and occur on known fish bearing streams (Figure 8-3, Appendix I, and Table 8-9).

6. Are road washouts of stream crossing fills present in the project area?
No washouts were present in the project area. A summary of washout risk at stream crossings within the project area is provided in Table 8-10.

7. Do recreation trails contribute to sediment or erosion problems?
The 14.6 miles of hiking and ATV trails in the project area were likely to have minimal erosion related impacts.

8. What proportion of the project area is non-forested due to forest roads?
The total land area dedicated to roads (permanent non-forested) was 1,998 acres, which was approximately 2 percent of the total project area.

Water Quality

OWEB Critical Questions

1. What are the designated beneficial uses of water for the stream segments?
Beneficial uses in the Nehalem River included those necessary to maintain salmonid habitat and aquatic life, domestic water supply, livestock watering, recreation and industrial water supply (Johnson and Maser 2000).

2. What are the water quality criteria that apply to the stream reaches?
Water quality constituents of concerns included temperature, dissolved oxygen, pH, nutrients, bacteria, turbidity and macroinvertebrate communities based on current water quality standards (or benthic indices of biological integrity for macroinvertebrates) for all upper Nehalem stream reaches. See Johnson and Maser 2000 for a detailed water quality analysis. DEQ defined the designated fish use in the Upper Nehalem watershed as "core, cold-water habitat." Under this designation, the seven-day average maximum temperature (7-Dmax) may not exceed 16.0ºC [60.8ºF]

3. Are stream reaches identified as water quality limited on the 303(d) list by the state?
The mainstem Nehalem River from its mouth to its confluence with Rock Creek near Vernonia, OR was listed as 303(d) water quality limited due to elevated summer water temperatures.

4. Are any stream reaches identified as high-quality waters or Outstanding Resource Waters?
Fish-bearing waters in four 6th field HUCs including Fishhawk, Buster, Upper Rock and Lousignont Creeks have been designated as Salmonid Anchor Habitats (SAHs). Approximately 90 percent of the fish-bearing waters adjacent to ODF lands in the upper Nehalem Watershed currently comply with thermal Properly Functioning Conditions (PFC) defined as reasonably achievable water temperatures given channel locations in the watershed and predicted thermal conditions under natural disturbance regimes.

5. Do water quality studies or evaluations indicate that water quality has been degraded or is limiting the beneficial uses?
Although water quality sampling was limited in the basin, the PSU analysis found no impairments for dissolved oxygen (D.O.), pH, bacteria (as represented by *E. coli*), phosphate, turbidity or contaminants during their data review in 1998 and 1999 in the middle and upper Nehalem Subbasins (Johnson and Maser 2000). The analysis noted elevated levels of nutrients, primarily nitrate, in the fall, winter and spring. However, recent data from the upper basin indicate a low level of nitrates suggesting the nutrient concern is more likely an issue in the lower portions of the basin.

The ranges of available data from the various sites are in line with reasonably achievable levels for all of the parameters in forested mountain streams. The data indicate water quality conditions on ODF lands are good and in accordance with biological use criteria.

ODF Supplemental Questions

1. What stream temperatures are reasonably achievable on State Forests?
Maximum 7-day surface water temperatures under historical reference conditions for the upper Nehalem watershed were modeled based on an assumption of mature forest conditions (MFC) growing adjacent to various stream channel sizes, elevation zones and distances from topographic divides in each subbasin, using the View-to-the-Sky (VTS) model (Appendix 9-2). Reference conifer, mixed and hardwood tree heights were modeled using 100-year site potential tree heights for the ecoregions and soil conditions encompassing the watershed. A VTS sub-routine was used that simulated openings in the riparian forest canopy to account for natural channel disturbances. This approach was included to provide potential variability and ranges to surface water temperatures that may have occurred historically. The resulting thermal regimes were assumed to represent reasonably achievable surface water temperatures consistent with historical conditions under occasional disturbances in mature forest conditions. Results are summarized in Table 11-9 for the lowest elevation stream on ODF lands in each sub-basin.

2. How do the current shade levels along streams compare to historic levels by sub-watershed and stream size?
Comparisons of riparian conditions by management basin per estimates of the historic setting are presented in Section 9.1.3.5. Extrapolations of shade, or the corollary view-to-sky, to water temperature have been made as summarized in Figures 11-4 and 11-5 and in Table 12-4. More than 92 percent of the current riparian shade conditions along fish-bearing waters adjacent to ODF lands offer a low probability of exceeding estimates of historic conditions.

3. How do the current stream temperature levels compare to historic levels by sub-watershed and stream size?
Comparisons of stream temperature by management basin are presented in Section 9.1.3.5. More than 92 percent of the predicted water temperature conditions along fish-bearing waters adjacent to ODF lands offer a low probability of exceeding estimates of historic conditions.

4. How do water temperatures compare to other nearby basins with similar flows and geology?
Water temperatures from nearby basins with comparable elevation, geologies and stream flows including streams in the Wilson and Kilchis River basins as well as streams in unmanaged portions of Nehalem watershed sub-basins are similar to surface water temperature conditions along ODF lands in the Upper Nehalem River (http://deq12.deq. state.or.us/wq/lasar). However, given the inherent variability in site conditions and monitoring records, use of data from nearby unmanaged basins or sub-basins as reference conditions to estimate reasonably achievable surface water temperatures for this watershed analysis was deemed less accurate than use of the VTS model to predict site-specific conditions (Section 9.1.4.2). Use of the VTS model for this purpose was determined to be a reliable approach within the zone where riparian stand characteristics have an influence on surface water temperatures.

Aquatic Resources and Their Habitats

1. What fish species are documented in the watershed? Are any of these currently state or federally listed as endangered, threatened or candidate species? Are there any fish species that historically occurred in the watershed that no longer occur there?
Table 10-1 lists fish species documented in the upper Nehalem River and their current management status. Warm water fish species have been introduced to Fishhawk Lake, near the Fishhawk Management Basin, and it is likely that rainbow trout from stocks outside the Nehalem River watershed have been planted in the basin.

2. What is the distribution, relative abundance and population status of salmonid species in the watershed? What is the distribution of fish species, by life stage, in the watershed?
Information on distribution, abundance, and population status of salmonids is presented in Section 10.3.1.1.

3. Which salmonid species are native to the watershed, and which have been introduced into the watershed?
All of the salmonid species present are native to the watershed. It is likely that rainbow trout from stocks outside the Nehalem River watershed have been planted in the basin.

4. Are there potential interactions between native and introduced species?
No information was available on the interactions between native and introduced fish.

5. What is the condition of the fish habitat in the watershed (by subbasin) according to existing habitat data?
Fish habitat conditions are described in Section 10.3.2.

6. Where are the potential barriers to fish passage? How many miles of fish-bearing streams are blocked by culverts?
A total of three passage barriers were identified on known fish bearing streams in the project area as a result of road crossings

7. What stream reaches have high, moderate, and low level of key pieces of large wood (> 24 inch conifer) in the channel?
The data on large wood are presented in Table 10-2. These data indicated that 61 percent of upper Nehalem surveyed stream reaches had a moderate amount of key large wood, twelve percent of the reaches had high levels of key large wood, and 27 percent had low levels.

8. Did any splash damming occur in the watershed? Where did this splash damming occur? Are the effects still apparent?
There is little documentation that splash damming occurred in and around the Project Area. The location of 11 permanent splash dams located in western Oregon rivers were documented in Hobbs et al. (2002). Three of these dams appeared to be in the upper Nehalem watershed, but there was insufficient detail to determine if they were located within the Project Area.

9. Are the tailed frog and Columbia torrent salamander potential present in the watershed? What are the habitat needs of these species?
Tailed frogs and Columbia torrent salamanders have been documented in the watershed. The findings of this reconnaissance survey indicate that torrent salamanders and tailed frogs occur in most of ODF management basins within the Nehalem watershed. The habitat needs of these species are presented in Sections 10.4.1.2 and 10.4.2.2 and in Table 10-7.

Limiting Factors

ODF Questions

1. Are there sub-watersheds where the current level of in-stream wood is a limiting factor for achieving properly functioning aquatic systems?
The available data on the upper Nehalem River critical wood habitat indicators were within the natural range of variation of wood levels in unmanaged forest streams and other reference values. Thus at a sub-watershed level, Nehalem River aquatic habitat was assessed as currently occurring within PFC. However, there are specific reaches with low levels of wood when compared to reference values (Figure 11-1). Aquatic habitat in these stream reaches could benefit by habitat enhancements that lead to increased levels of wood loading.

2. Are there sub-watersheds were stream sediment deposition (associated with hillslopes and/or erosion) is a limiting factor for achieving properly function aquatic systems?
The available data on the upper Nehalem River substrate habitat indicators are within the natural range of variation of unmanaged forest streams and other reference values. Thus at a sub-watershed level, Nehalem River aquatic habitat was assessed as currently occurring within PFC. However, specific reaches exist with high levels of fines when compared to reference values (Figure 11-2). Aquatic habitats in these stream reaches could benefit by habitat enhancements that lead to reductions in fine sediment and decreased inputs of fines in the future.

3. Given the stream temperatures that are reasonably achievable, what is the likelihood (rate as high, moderate, low, or unknown) that stream temperatures and/or shade conditions are a limiting factor for achieving properly functioning aquatic systems?
Likelihood that stream temperatures currently limit the achievement of PFC for surface water thermal regimes is low as shown in Figures 11-4 and 11-5 and summarized in Tables 11-x; and 12-4.

4. Are there any other conditions limiting the achievement of PFCs?
No other conditions we identified as limiting the achievement of PFC in aquatic habitats surveyed.

Alternative Vegetative Management

ODF Questions

1. *Given current management strategies, which sub-watersheds have aquatic and riparian conditions that have already achieved the PFC?*

Many of the 6th field HUCs and Management Basins are currently predicted to offer riparian conditions characteristic of PFC for large wood recruitment and shade/surface water temperatures (Table 6-2; 9-x; Appendix 9-2; Table 11-10, Table 12-2). Details are summarized in Sections 11.3, 12.1 and 12.2.

Large Wood Recruitment Potential

A discussion of sub-watersheds with a potential to achieved PFC for large wood is provided in Section 12.1.1.1. None of the sub-watersheds currently support riparian conditions consistent with OWEB reference stand conditions PFC for large wood (> 24in. diameter). Based on the estimated natural historic distribution of stand characteristics supporting high, moderate and low recruitment potential of large wood, the Fishhawk Management Basin is currently consistent with PFC and the Buster and Wilark Management Basins are approaching PFC (Table 6-2).

Water Temperature

Currently, all management basins are consistent with PFC for water temperature, as estimated from predicted historic forest-age distributions of young and mature stands, with the exceptions of Lousignot and Crawford Management Basins in the Astoria Forest District.

2. *Which sub-watersheds have aquatic and riparian conditions suitable for the development of the PFC in a 50-yr timeframe? In 100-yr timeframe? Longer than a 100-year timeframe?*

Many of the riparian zones adjacent to fish-bearing waters in the project area are on a trajectory to PFC and should achieve such conditions within a 50-year time frame under proposed management strategies.

Large Wood Recruitment Potential

All of the Management Basins are predicted to exceed conditions consistent with PFC, for large wood recruitment within 50 years with the exception of the Quartz, Sager and Northrup Management Basins in the Astoria Forest District. Discussion of the anticipated distribution of riparian stand conditions in comparison to historic PFC for the 50-, 100- and greater than 100 year time frames is included in Section 12.1.2.

Water Temperature

Discussion of the anticipated distribution of riparian stand conditions in comparison to historic PFC for the 50-, 100- and greater than 100 year time frames is included in Section 12.2.2. Nearly 98 and 97 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem watershed are anticipated to develop sufficient riparian stand characteristics to generate PFC for shade and water temperature in the next 50 and 100 years, respectively. All of the Management Basins are predicted to be consistent with PFC in 50 years with the exception of the Quartz Management Basin.

3. For those sub-watersheds where it will take longer than 100 years to develop the PFC, prioritize by stream reach (and map) for alternative vegetation management to achieve the PFC.
Specific stream reaches that are anticipated to exceed PFC distributions of surface water temperatures after 100 years are mapped in Figure 12-3.

Slope Stability

ODF Questions

1. Are there landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts? If so, identify the specific hillslopes and stream reaches, describe why they pose a high risk to streams, and describe how management will affect possible stream sediment or scour impacts?
Landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts can be identified based on the slope gradient, landslide density, and debris flow probability maps provided in this section for each of ODF's management areas (see Table 13-1 and Appendix D, Figures D-9 to D-59). The specific stream reaches likely to be impacted can also be identified using the debris flow probability maps (both scour along the predicted paths and deposition at the downstream end of the predicted path). Information was not available to evaluate how forest management will affect debris flow risk and ultimately the ecological condition of channels.

2. *Which of the mechanisms (shallow landslides, deep-seated landslides, and soil creep) provide a substantial source of sediment to streams?*
In certain portions of the study area, such as along the western margin, shallow landslides and debris flows likely dominate the supply of sediment to large fish-bearing streams and rivers. Inner gorge slides are also likely important in certain areas. Soil creep is probably minimal. In other, less highly dissected and lower gradient portions of the Nehalem Project Area (northern and eastern portions), the role of shallow slides and debris flows is probably diminished (< 50%) with soil creep becoming more important. Over the entire area, post fire erosion is probably significant and may dominate the erosion regime in the form of landslides, debris flows, inner gorge failures, surface erosion, and gullying over the long term (i.e., centuries).

3. Which steep slopes will likely provide future in-stream key pieces of large wood to debris flow prone channels?
In general, most of the Nehalem watershed has a limited ability to deliver wood to fish-bearing channels by debris flow because of the overall low potential for shallow failures and debris flows. The highest potential for wood delivery from debris flows exists in the southwest corner of the study area. Results of the debris flow model are presented in Appendix D, Figures D-8 to D–59 for each of the 13 management basins, organized by HUC6th-field watersheds.

Road Management

ODF Questions

1. Which roads need review by ODF for repair and why? What are the specific locations of the road issues?
A total of 85 road segments in the project area were identified and prioritized for repair (Table 14-1).

2. What road segments should be considered by ODF for vacation or relocation and why?
No road segments within the project area were identified in need of vacation or relocation.

3. Which stream crossings identified in the assessment phase, including fish passage barriers and crossings in poor condition, should be considered for replacement?
A total of five stream crossings were identified for consideration of replacement within the project area (Table 14-2).

15.3 DATA GAPS

The following critical data gaps were identified during the upper Nehalem River Watershed Analysis.

1. Riparian Conditions along stream channels within Clatskanie River contiguous parcels.
2. Field surveys are needed to detect deep seated landslides.
3. Detailed site-specific field surveys of steep slopes would be required to determine basin potential and sediment delivery potential of particular areas.
4. More detailed information is needed to assess the effects of nitrate-nitrogen levels in Quartz Creek.

5. Hydrology data gaps identified include forest-specific streamflow data including low flows in managed and non-managed streams.
6. Additional field information is needed to assess wetlands and in the Project Area.
7. Additional field information is needed to assess exotic/invasive plants.
8. Additional site-specific information is required to evaluate the risk posed by debris flows to fish-bearing channels.
9. To evaluate how forest management will affect debris flow risk and ultimately the ecological condition of channels requires additional information on rates and spatial patterns of timber harvest.
10. To estimate how mass wasting would alter channel and valley floor morphology detailed field surveys in landslide and debris flow deposition zones are needed.
11. To obtain a more quantitative and accurate estimate of the various rates of erosion in the Nehalem watershed would require additional aerial photograph interpretation and field surveys.
12. To verify the need for culvert replacements at five road crossings further field assessment of these crossings are needed.

15.4 CONFIDENCE EVALUATION

Multiple sources of evidence were brought forward from each of the modules, leading to the conclusions stated herein. We attempted to use the weight of available evidence in making conclusions when certainty was unclear. The resource analysts have a moderately high level of confidence the location of resource impacts and probable causes were accurately represented via this synthesis section.

The analyst team wishes to re-emphasize that the map products provided herein are a simplified representation of landscape conditions. They should not replace field level determinations of sensitive areas based on the descriptions of landforms and site conditions described in each module.

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